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Communications—Electronics—Photography

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BPA

SIGNAL

Communications-Electronics-Photography

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AFCEA CONVENTION REPORT IN JULY ISSUE

Cover

SIGNAL's *cover picture is a new Raytheon "Flight Tracker" radar with a giant 40-foot antenna which will be a key part of a complex Civil Aeronautics Administration air surveillance system that follows and helps safeguard all aircraft during every stage of flight.*

Effectively covering more than 125,000 square miles, a single set can picture traffic movement for 15 monitor screens simultaneously in different CAA centers. Radar scopes that display air lane maps pinpoint plane positions at distances up to 200 miles, altitudes to 70,000 feet in all kinds of weather.

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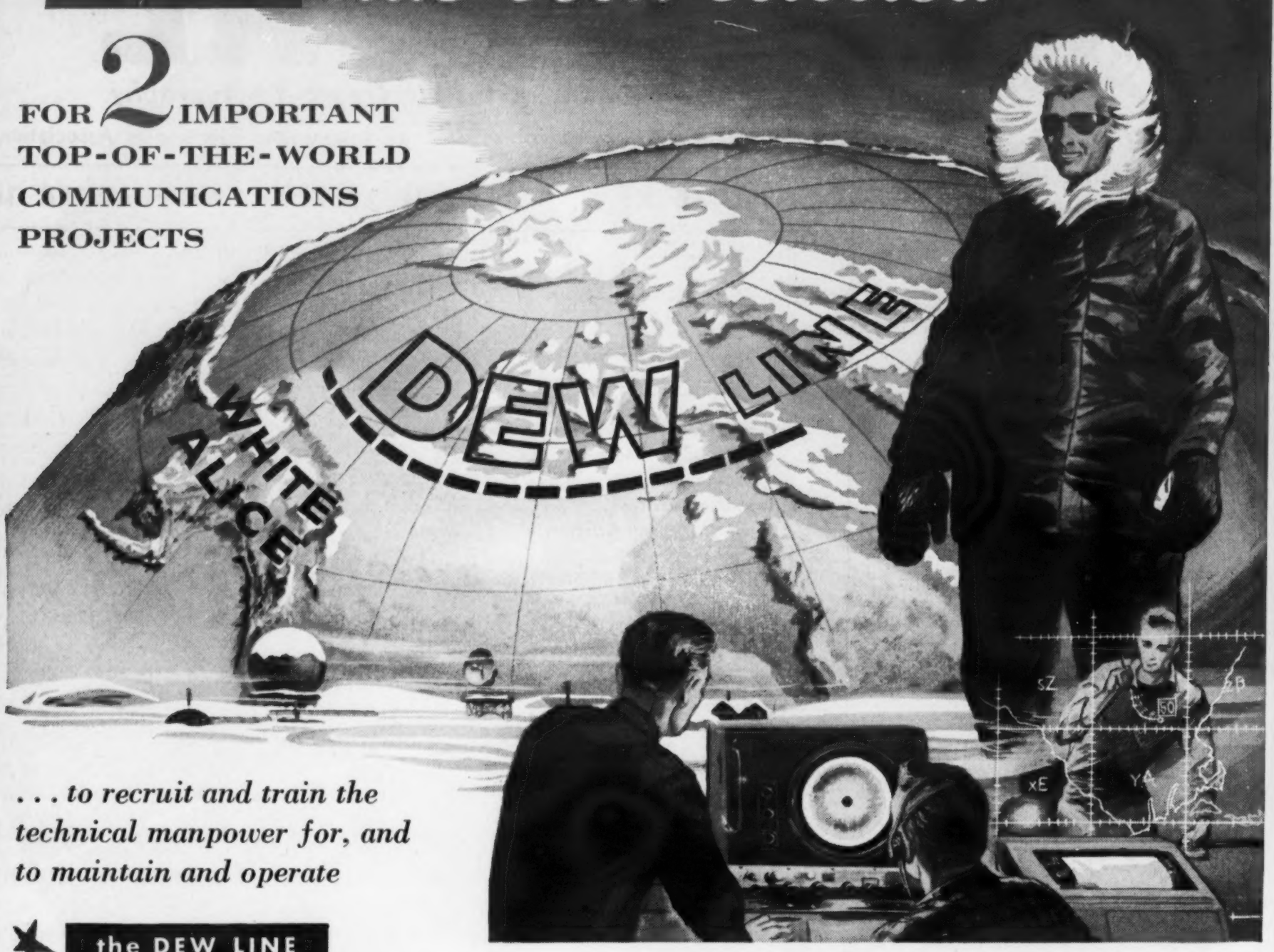

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BUAER'S NEW AVIONICS DIVISION MEETS ELECTRONIC WEAPONS NEEDS OF NAVY AIR ARM

U. S. Navy Photo

Brand new in the Navy Bureau of Aeronautics, the Avionics Division is responsible for all aspects of research and development of electronic fire control and weapons launching equipment for Navy aircraft and guided missiles. This Division deals daily with problems undreamed of as recently as World War II. To ensure that our Navy air arm will continue to be the most effective and ultra-modern in the world, it plans in terms of 10, 15, or 25 years hence. Its personnel must think in terms of Mach 10 speeds or altitudes of 20 or more miles.

This vital R & D mission, which was formerly accomplished by the joint efforts of Armament and Electronics Divisions, has been merged in the Avionics Division to include a wide variety of electronic functions. Among these are ground station telemetering and instrumentation; guidance systems; warheads; fusing and launching of guided missiles; fighter attack systems; airborne early warning systems, and many others.

To coordinate the many programs under its jurisdiction, the Division has established a "Project Manager" system of organization. This system provides maximum streamlined operation and facilitates industry contacts as well. The personnel of the Avionics Division thus are enabled to develop with maximum facility the incredible electronic equipment needed by today's and tomorrow's aircraft and missiles. With their special knowledge and far seeing outlook, they will make certain that the new higher speeds, altitudes and ranges of aircraft are utilized to full effectiveness.

◀**FJ-3 Fury goes aloft** from one of the after catapults of the U.S.S. Forrestal. An F2H-3 Banshee is in the foreground. Electronics developed by BuAer's Avionics Division provides planes such as these with their highly effective weapons and control systems.

▲ **Engineer at Ford Instrument Company** opening salt spray chamber in which equipment for BuAer is being subjected to environmental test.

This is one of a series of ads on the technical activities of the Department of Defense.

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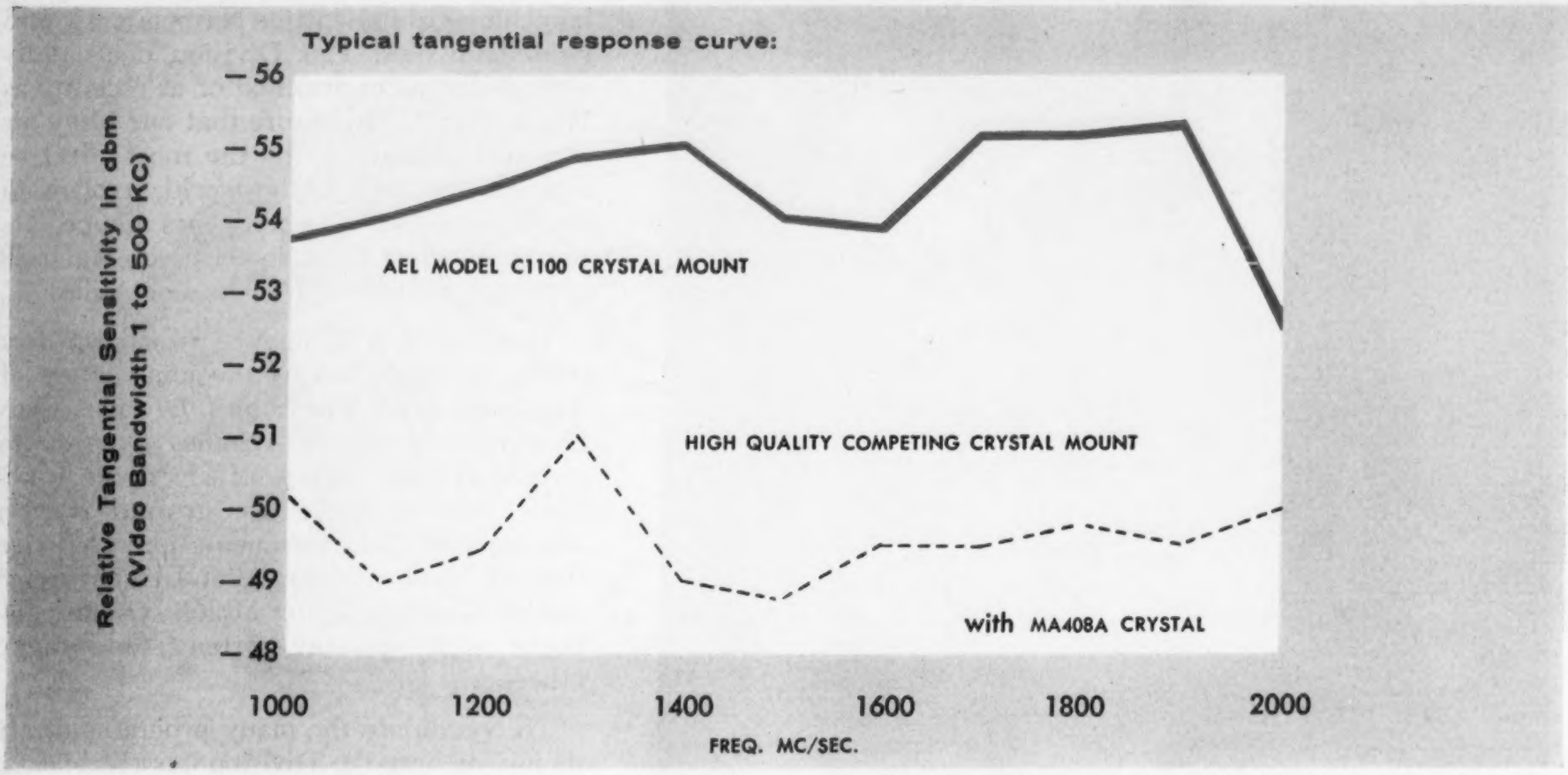
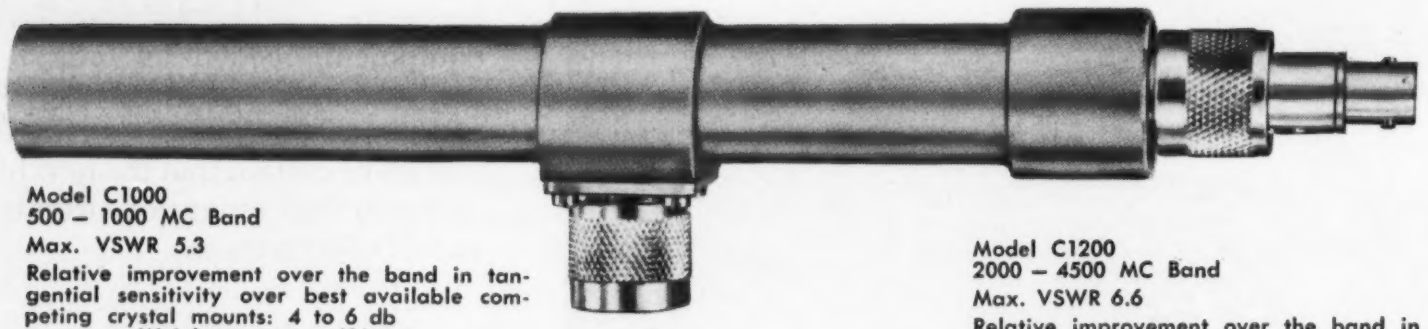


NOTE:

Tangential sensitivity is defined as the power level of the incoming signal at which signal plus noise equals twice noise. "TS" is read when the bottom of the noise inside the pulse is tangential to the top of the noise outside the pulse. It is measured in – n dbm, where "n" is the power level of the signal in db below one milliwatt.



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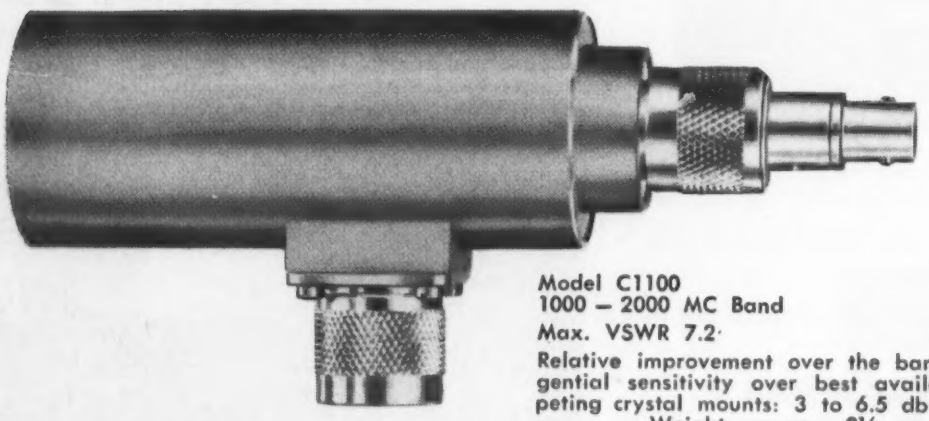

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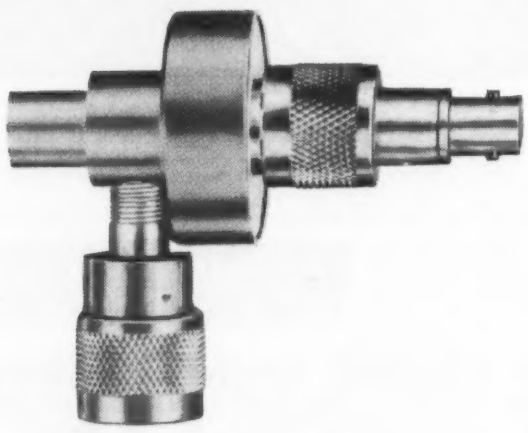

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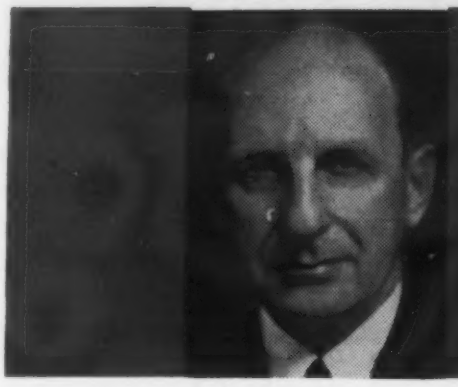
COMMUNICATIONS IN THE NUCLEAR AGE



by James E. Dingman
Director of Operations, Long Lines Dept.
American Telephone and Telegraph Co.

A New Dimension

GOOD COMMUNICATION SERVICE is dependent upon many things—research, design, construction and even so intangible an item as the communication man's pride in performance. But no single effort or objective is more important than reliability, or continuity of service. For a communication facility that fails, particularly in time of emergency, is of questionable value to the user.

Constant Vigilance Required

Protecting vast and complex nationwide communication networks against interruption requires constant vigilance and is a never-ending task in the Bell System. Interruption may stem from many sources, some natural, some man-made. The capricious, uncontrollable forces of nature, in the form of floods and hurricanes, are good examples. The curious phenomenon of sun spot activity with its disruption of international radio communications is another.

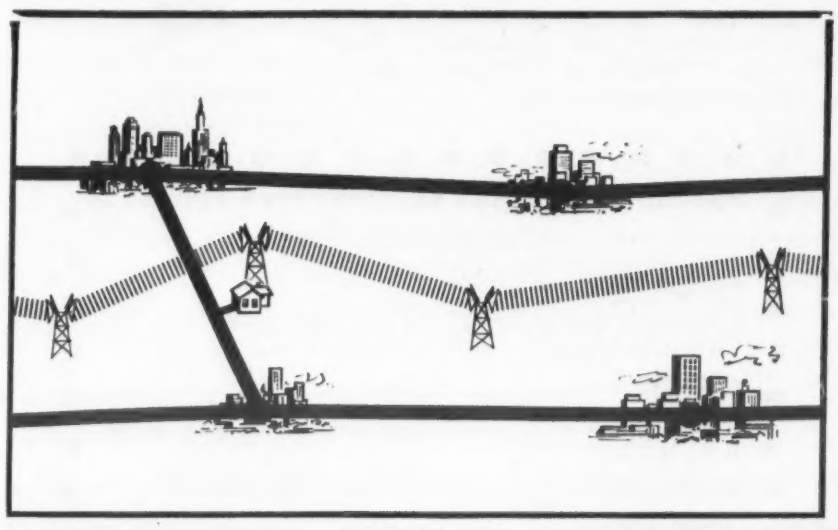
There is also man himself; a typical example is the farmer who cuts a transcontinental cable while planting a fence post, or a contractor who rips through a cable while bulldozing a roadway. Both unwittingly terminate television programs, hundreds of telephone conversations and all other information that may be routed through the cable they have severed.

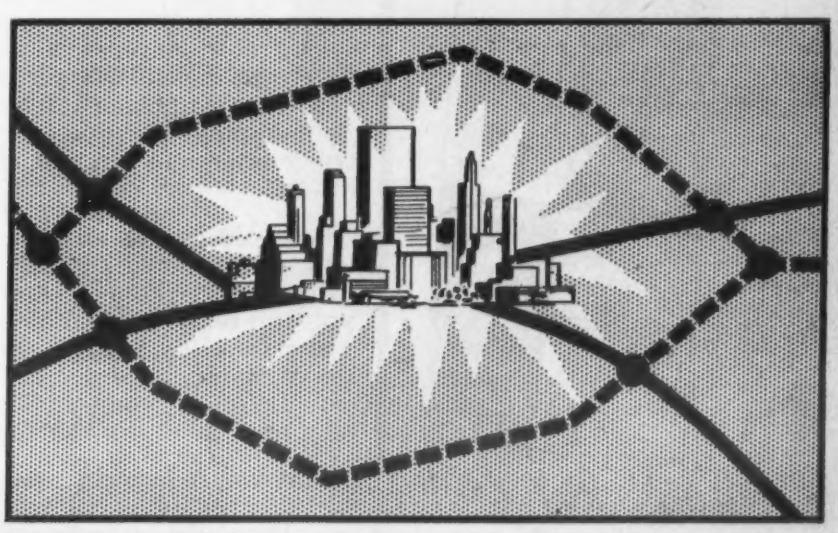
Fortunately, the Bell System's national network of communications is basically comprehensive. Telephone people have always been mindful of the need to protect services by diversifying facilities. Because of the scope and flexibility of long distance routes and interconnecting lines, services can be routed easily around a single trouble area, or several major metropolitan centers if necessary.

This Nuclear Age

In recent years, however, telephone engineers have been confronted by a new concept, brought on, as one might suspect, by the pervading influence of the nuclear age. The nuclear family of weapons, with their awesome potential for destruction and devastation, has introduced scores of new problems to the overall job of maintaining communications. They have, in fact, brought a new dimension to the task of planning and constructing communication plants.

The Bell System has an answer to the many plant protection problems thrust on us by the dawning world of atomic energy and all of its known ramifications. We have launched—and have half completed— the construction of new facilities that will enable us to maintain communications across the length and breadth of the country in the face even of





The radio relay express route (left), like a modern express highway, cuts through the open area between large metropolitan centers and provides an interconnection point for existing communication routes. A typical large city (right), considered a potential target area, is bypassed by radio relay or cable facilities. The route forms a complete ring around the city, allowing for several interconnection points with existing through-city lines.

severe, large scale attacks with nuclear weapons.

These facilities are known simply as "express" and "by-pass" routes. The express routes are direct communication highways that span long distances and avoid critical target areas. One such route runs from Maine to Southern California, and doesn't go through a single major population area.

The by-pass routes form a partial or complete ring around cities or towns. These provide access in and out of the by-passed area and give a trouble-free path around the city when necessary.

Present Communication Network

But, before getting into a detailed discussion of the current protection program, let's review the development of Bell System facilities prior to the advent of the atomic bomb.

Since the earliest days of telephone expansion, the plant that was built to provide facilities between widely separated communities was also used, as a matter of economy, to service intermediate communities along the same route. As the communication network expanded, several different pathways usually have become available between any two cities. Thus, only the worst and most widespread storms and floods have more than local effect on the Nation's communications.

The town-to-town concept of communication systems has given birth to the one major hazard, however—the heavy concentration of circuits and terminal installation in the big cities. To alleviate this condition, circuits that did not have to be routed through the large metropolitan centers have now, in many instances, been routed around them. This was made possible by the construction of large capacity routes which avoid such locations as New York, Philadelphia, Washington and Pittsburgh. To a great extent these routes, linked to switching centers outside the big city areas, minimize the possible effect a bombed-out city would bring to bear on the nation-wide communications network.

Expansion of Express and By-Pass Routes

The increased demand for long distance communication in recent years has exhausted the capacity of many of the older routes. This, plus the chilling knowledge of what an aerial attack could do to this country, prompted telephone management to review and re-draft plans for the protection of service.

And now, well under way, are the express and by-pass routes previously mentioned. There are many individual links, of varying lengths, totalling some 6,000 miles. When completed in 1958, they will skirt, by substantial margins, all of the country's larger cities, military installations and generally congested areas which might be attractive bombing targets.

The new routes will have a nominal capacity of about 3,000 circuits. As the first groups of circuits go into service, they will be able to carry all military traffic and much civilian traffic.

Express routes are so-named for their similarity to the super-highways and toll turnpikes that are beginning to interlace the Nation. These express routes have branches and interconnections with existing cables and microwave systems which provide access to the cities and towns they avoid. Whenever necessary, terminating traffic can be routed "in" and orginating traffic routed "out" of these towns.

By-pass routes are intended for situations where existing routes passing through a town or city are adequate for present needs and for substantial growth. In these instances express routes are not justified. By-passes are for circuits which do not terminate in the town, but merely pass through and which can therefore be routed around the town—well outside of the potential danger area.

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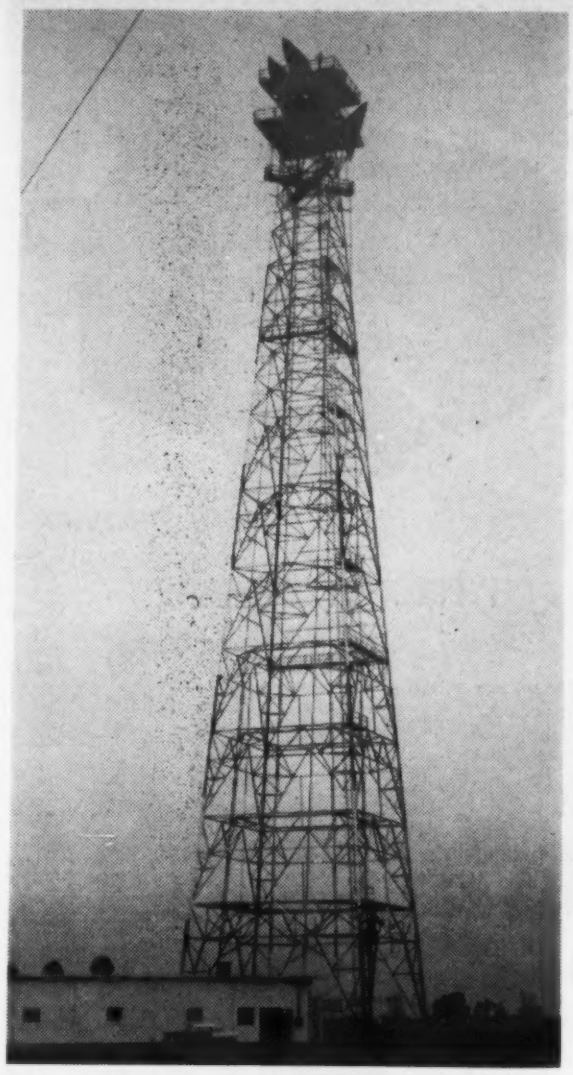


At certain interconnection points along both the express and by-pass routes, radio relay main stations like the one pictured here, will tie new routes into the network.

Engineering Objectives of Express and By-Pass Routes

In shaping this program of express and by-pass routes several objectives have been kept in mind.

1. All the telephone message circuits between two cities should not be carried over the same route. They should be divided among different routes, so that all circuits will not be exposed to the same hazards. At least one of the routes between any two cities in the country should not pass through any target area.

2. Similar dispersion should be provided for essential civilian and government private line circuits. There should be adequate capacity along the various routes so that if one or more is completely destroyed, service may be restored quickly over other pathways.

3. Suburbs of large cities should be provided with connections to the by-pass and express routes so that communication between the fringes of possible disaster areas and the rest of the Nation can be maintained.

Connection of Fringes to Express and By-Pass Routes

So far our attention has been focused principally on the protection of intermediate sections of inter-city circuits. If a city is bombed, however, it will be necessary to establish immediate communication to the fringes or suburban sections of the damaged area. In the past, inter-city communications were routed largely through the center of the city and, consequently, would be severed if the city were destroyed. To assure continuity of service to suburban areas which might be expected to remain unharmed, cables are being constructed to connect fringe areas directly to the by-pass or express routes without going through potential damage zones. Some of the circuits from suburban areas to other cities can be operated regularly over the new routes.

In addition, facilities are being provided at many interconnection points on the express and by-pass routes to permit the rapid creation of totally new circuits with direct connection to outlying points in case of disaster.

Types of Facilities Used

Radio relay systems and coaxial cables are being used in most of the new construction because they can provide the large quantities of circuits needed.

The points where the express and by-pass routes interconnect with other routes have been carefully selected from the standpoint of accessibility and housing of personnel. At many of these locations, continuous coverage is necessary. In some cases, where the location of the building or its relative importance justifies such treatment, buildings are blast-resistant. A minimum number of windows have been built into the structures and careful air-filtering will give added protection against radioactive fallout. Water supplies have been provided which can be maintained free of radioactive matter.

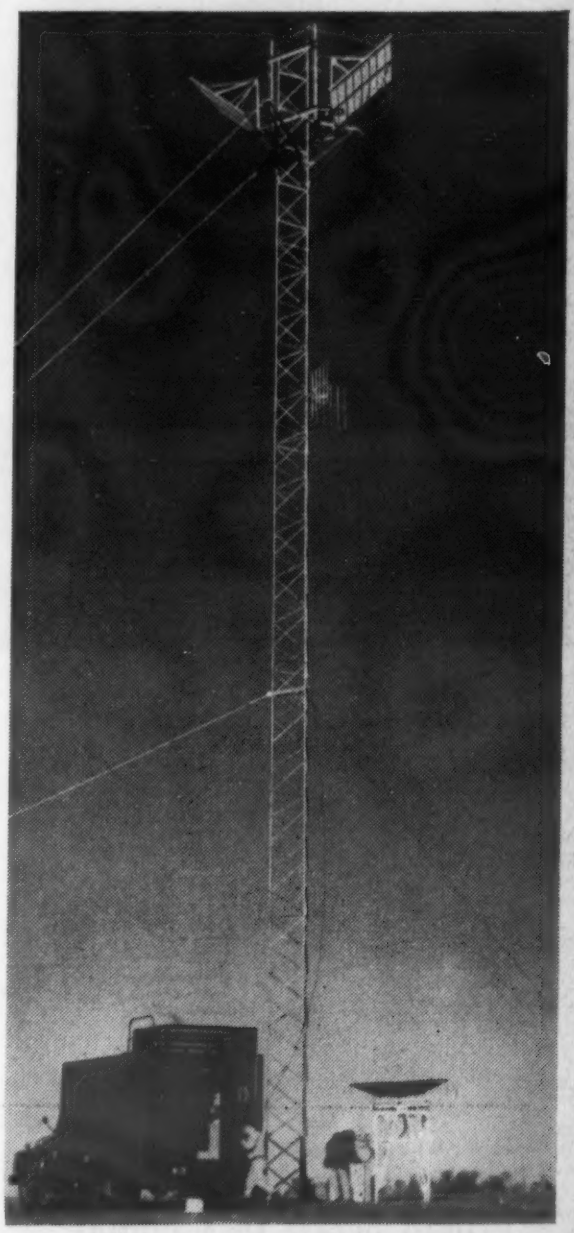
Emergency Power and Rapid Restoration Plans

To insure continuity of operation in the event of commercial power failure, all stations are equipped with battery power plants. In addition, emergency engine alternator units of sufficient capacity to carry the entire station load are installed. These emergency units start automatically when commercial power fails.

If service were interrupted due to the destruction of a radio relay station, rapid restoration has been made possible through the use of truck-mounted radio units, located at strategic points across the country. Each mobile unit consists of transmitting and receiving microwave radio equipment, associated power and testing equipment, waveguide and antenna equipment, emergency engine alternator and a scaffold type tower. This unit can restore one transmitting and one receiving broad band radio channel. The radio, waveguide, antenna and testing equipment are mounted on the vehicles in such a manner that the entire unit can be quickly placed in service. The power generator is trailer-mounted.

Meet The Challenge— A Bell Policy

In line with its long standing policy, the Bell System will continue to take any and all reasonable measures to assure continuity of telecommunication services. Its record in designing plants that will provide this service has been good. While the possibility of nuclear bombing with the simultaneous destruction of many large cities has introduced another challenge, this challenge is being met with a program of by-pass and express routes. The extent to which these methods provide the protection necessary for the communications vital to the Nation's defense is the subject of never-ending study and evaluation, and we are keenly aware that survival may be the reward of vigilance.



This mobile unit is capable of replacing damaged radio relay stations. Placed at strategic locations around the country, one of these could be rushed to any trouble area.

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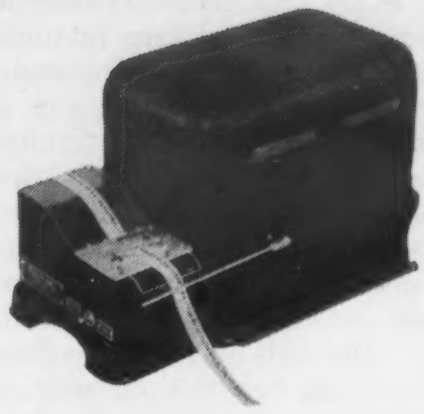

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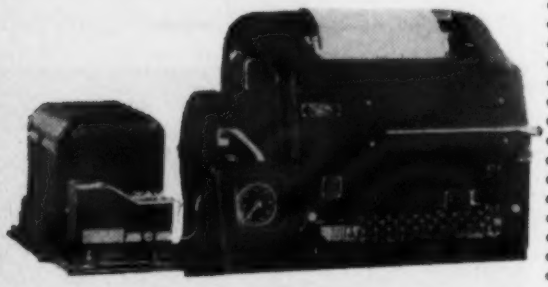

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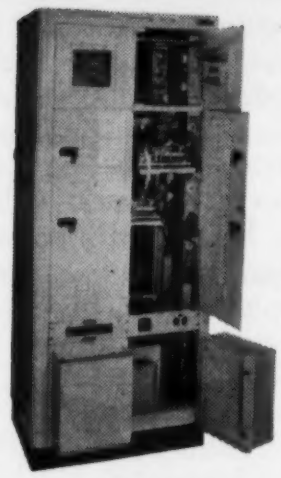

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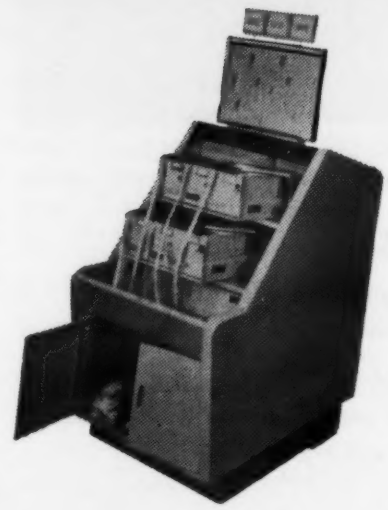

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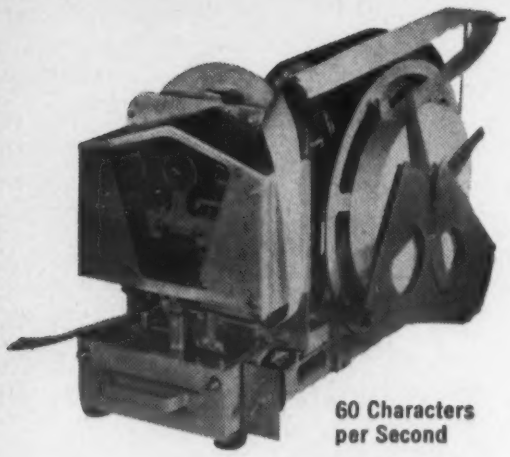

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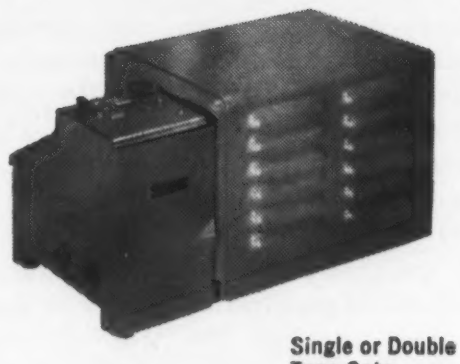

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TRANSISTORS . . .

a revolution in electronics

by Daniel E. Noble

Executive Vice-President, Motorola, Inc.

THE REVOLUTION IN ELECTRONICS has started, and the tiny transistor is the impetus behind the change. Wherever transistors can be used in electronic equipment of all kinds, they offer the potential for new dimensions in reliability, in packaging, and in power consumption. To characterize the transistor, it is a tiny slab of mono-crystalline germanium or silicon, which has been modified by alloying or diffusion techniques to make a device capable of amplifying current, in a suitable circuitry arrangement.

It may be interesting to compare this bit of solid material (which has no moving or delicately suspended parts, and no power-consuming cathode) with the vacuum tube. Compare the vacuum tube micro-dimensioning and micro-spacing of plates, grids and cathode, and the electric furnace to heat the cathode, with the transistor which is essentially a vibration-proof, shockproof, heaterless slab of solid semiconductor material. Fundamentally, the structure of the transistor is so much more rugged and reliable than the structure of a vacuum tube that the difference requires no emphasis.

The advantage of the transistor over the vacuum tube in terms of increased reliability is not, however, the simple advantage of the rugged mechanical structure; it goes far beyond this. The vacuum tube generates heat and it frequently operates with voltages of 180 or higher. It utilizes condensers and resistors in circuitry subjected to very substantial voltage and current values, even in low power level circuitry configurations. Consider the heat factor.

The digital computer, utilizing vacuum tubes, requires the addition of a refrigerated air-cooling system, even though the counter tubes work at low power levels. The same computer, utilizing transistors, requires only a fraction of the power input and no refrigeration. A point of note is that the failure of equipment using vacuum tubes is not only the failure caused by tube defects or tube malfunctioning, but it is also the failure of circuit components which have been subjected to the excessive heat, the excessive currents, and the excessive voltages which characterize vacuum tube circuitry.

Practicability

In comparison, for transistor low power level circuitry, low voltage and low current is all that is needed. 6, 9, 12, 14 Volts may be used with transistors at one's convenience, and where necessary the total circuitry for a multiple transistor device may be limited to microamperes or to a few milliamperes. Thus, in transistor circuitry, with 12 Volts as the maximum voltage and with no significant heat generation, the components are not challenged by power supply needs which can destroy or limit the life of condensers and resistors.

If an electronic equipment is to serve as a useful tool, it must be reliable, and the maintenance procedures must be practicable. No matter how beautiful the scientific embodiment of the device may be, it is worthless for industry application if it is unreliable and if the maintenance is a headache in field operation. In the simple device, the maintenance is simple, but as the devices get more and more complex, the maintenance problem rises and rises until there seems to be no easy solution. Witness the rise in the complexity of consumer goods broadcast receiver equipment from the ordinary home radio set, to black and white TV, and now to the supercomplexity of the color television unit. There seems to be a natural law of nature, for technological devices at least, prescribing a path leading ever upward toward greater and greater complexity. Unless we rationalize each successive complex design for sensible maintenance procedures, we will eventually reach a saturation of complexity where maintenance will be impossible.

In military electronics, as well as in industrial and commercial electronics, there is a trend, I hope to see accelerated, toward the design of devices with unit or module and submodule construction, and wherever

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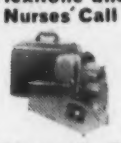

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possible, toward sealed modules which will be replaced but not be repaired in the field. This design trend offers two distinct advantages toward improved usability of equipment. (1) The sealed module will prevent undisciplined tinkering on the part of the over-zealous maintenance man. (2) The module and sub-module configurations will permit routine servicing measurements to be made to locate the sub-assembly which is at fault.

This routine location of the faulty sub-section reduces immediately, the *total* complexity of the whole equipment structure, to the *limited* complexity of the single faulty module or sub-module. The competent serviceman can then either locate the faulty part in the sub-module or replace any sealed module with a standard replacement unit.

All this would seem to be a digression from the main subject of transistors, but you can be assured that it is not. Modular and sub-modular construction, and sealed modules, had very limited practicability as long as we were faced with the need for vacuum tubes which are plug-in consumable devices and which contribute a nearly unsolvable problem of heat control.

Modular Construction

Now, with transistors, with low heat generating characteristics and with low voltage operating requirements, it is possible not only to design printed circuits using transistors and other components in a replaceable assembly, but it becomes possible also to seal an entire functional circuitry configuration in a module. This sealed module may be expected to have a life expectancy equal to that of the life of the total equipment. Actual module replacement would be limited to a small percentage of defective units. With transistors, modular construction becomes practical.

One of the revolutions inherent in the application of transistors is an accelerated move toward modular and sub-modular construction for easy servicing, for flexibility of design changes, and even for retro-fitting where the modernizing of a unit becomes possible through the change of a module. Modular construction, sealed modules, printed circuitry, and simplified servicing are all part of the pattern which will be accelerated by the wide application of transistors and semiconductor devices.

Now a lot of nice things have been said about the transistor, but nature has a habit of mixing a suitable proportion of negative factors with the positive, even when the positive ones are dominant. It is a mistake to assume that the transistor is simply a substitute for a vacuum tube. The transistor, in terms of functions, will oscillate and amplify as a vacuum tube will, but its characteristics and its operating parameters differ widely from those of a vacuum tube. In meeting the requirements of the design of equipment utilizing transistors, a substantially new approach must be made.

Applications

The transistor is a rugged, reliable device capable of exceptionally long and successful performance, but it must be emphasized, that it should not be called upon to work in circuitry configurations for which it has no talent. For example, the transistor is not a high impedance input device. It is possible to arrange a combination of transistors to produce the equivalent of a high impedance input, but in general, the simple transistor consumes power even in the input circuit, and energy is required to drive it. The output and input of a transistor triode are rather closely coupled, and variations in the load will reflect back into the input.

The transistor is also temperature sensitive, with substantial parameter variations with temperature changes. So far, we have no transistor with the equivalent of the screen grid isolation, commonly associated with vacuum tubes. High frequency transistor amplifiers must be neutralized. Also, the transistor does not perform importantly as a stable d.c. amplifier.

With all its faults, the transistor is still a magnificent device. By the use of compensating circuitry and inverse feedback circuitry, it is possible to adjust the circuit parameters to produce exceptionally reliable results despite the limitations. The vacuum tube is no paragon of all virtues, but we have learned to compensate for its faults, and we must learn to do the same for the limitations we find in transistors.

The transistor has been rather slow in moving into commercial equipment and the wide variety of electronic applications. Many of you who have not made a study of the subject are undoubtedly wondering why industry has been so slow in adopting the transistor.

Availability

First of all, remember that for a number of years the transistors in production and available on the market were essentially audio amplifying

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devices. They were suitable for hearing aid applications and for minor audio amplifier construction. There were no suitable power transistors on the market, and there were no satisfactory radio frequency transistors available in suitable quality and quantity.

In the last few years, there has been a change in this situation. Transistors are rapidly becoming available commercially for applications up to about 12 megacycles. In the laboratory, transistors have been made for successful oscillation and amplification applications as high as 400 megacycles, and in a few isolated instances, as high as one or two thousand megacycles.

Shown above: Motorola "Power Voice" mobile speaker has a built-in transistor amplifier which provides up to 10 watts audio output when fed by the usual mobile communications receiver with 1.5 to 2 watts audio output.

You have probably noted that hybrid car radio broadcast receivers are on the market, utilizing tubes operating with 12 V. plate supply in all the preliminary stages, and employing power transistors for generating the audio power to drive the speaker. Tiny, transistorized, portable broadcast radio receivers have also hit the market in the past couple of years.

Potential Not Realized

But, with all of this activity, there is still no substantial pattern of transistor application to industrial and commercial equipment, either in mobile communications, in the digital computer, or in other electronics fields. Why? The answer to the question is covered in three sections.

(1) R. F. transistors satisfactory in performance and price are just coming on the market in quantity, and a substantial history of performance and characteristics has not yet been established. There is always a substantial delay between the availability of a component and the release of the component as a part of a matured commercial device. There has not been time enough to pass through that cycle.

(2) The problem is not one of simply substituting transistors for vacuum tubes, and new circuitry configurations. New compensation means and optimum circuit design must be developed to utilize the best characteristics of the transistor and to neutralize the negative factors. It takes time for the engineers to become familiar with all the idiosyncrasies of transistors in the great number of circuitry applications.

(3) The germanium transistor, which is the only one available in quantity and within commercial price range, has a definite heat limitation of a nominal 60°C. environment, with an upper limit not exceeding about 80°C. If it had been possible simply to put a few transistors here and there in existing vacuum tube equipment, the rise in the application of transistors to modern electronic circuitry would have been accelerated. This was not practical because vacuum tube equipment generates excessive heat, and the transistors would have been subjected to temperatures beyond reasonable operating tolerances. Note here that, when equipment is completely transistorized and the vacuum tubes, with their inherent furnace characteristic, are removed, there is no heat problem, but the placing of transistors in the usual high temperature vacuum tube equipment is not a sound approach.

Silicon or Germanium

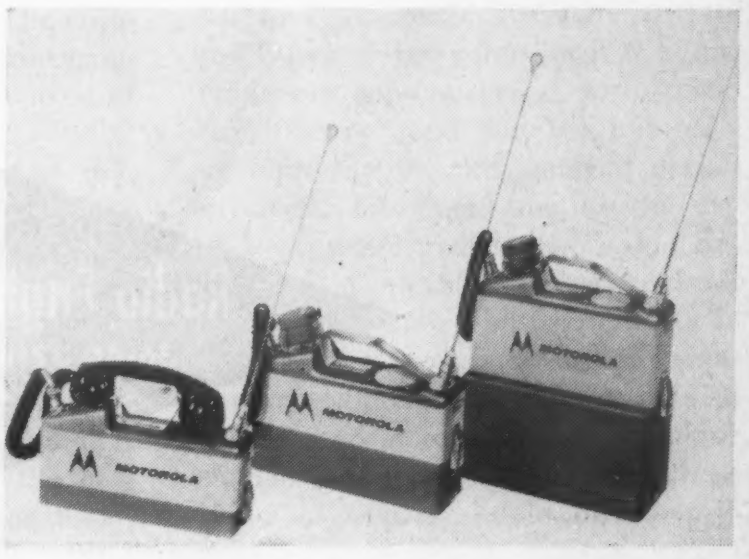
The question will immediately be asked as to whether or not silicon transistors should be used instead of germanium transistors. The answer today is emphatically "No." In general, it may be said that it is possible to make better transistors, as well as lower cost transistors, using germanium, when the temperature can be held under 80°C. At present, the silicon transistor is a high cost specialized device with characteristics especially suited for operating temperatures above 100°C. In the great majority of industrial and commercial electronic equipments, there is no need for an equipment environment specification exceeding 60°C., if you do not build heat-generating devices such as vacuum tubes into the equipment along with the transistors.

A New Field

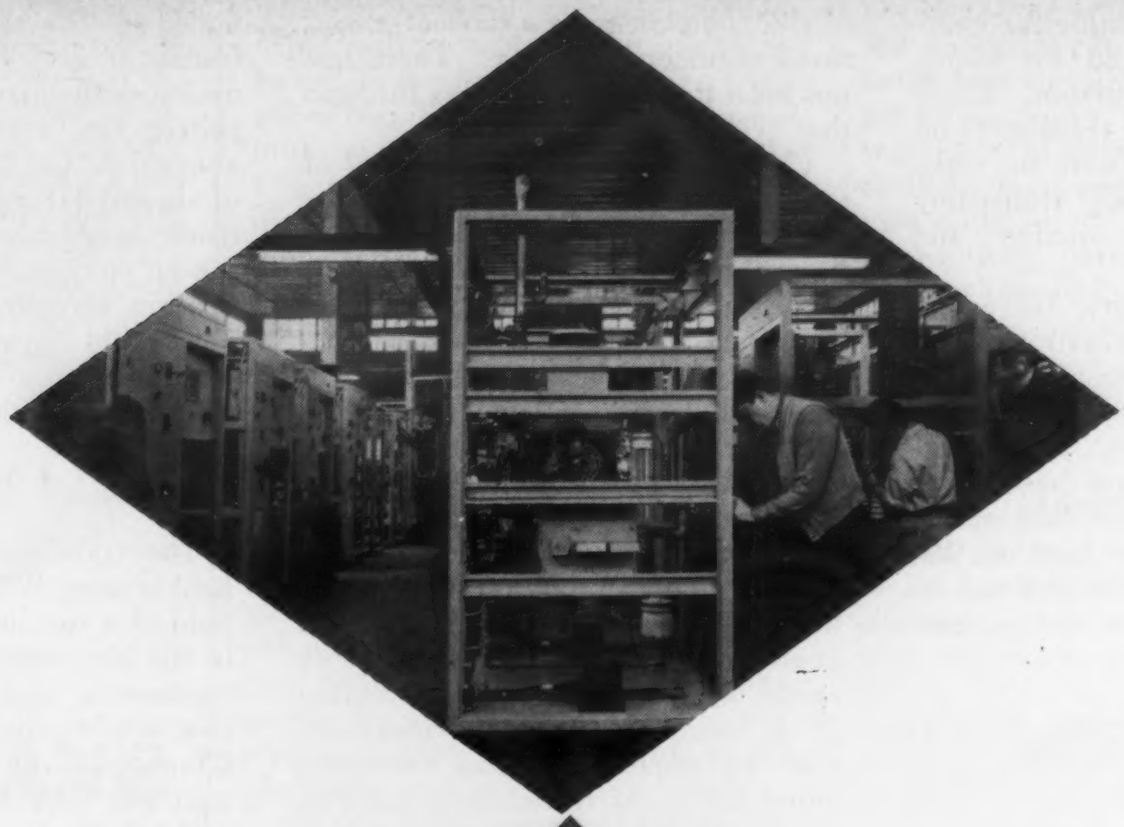
The transistor and semiconductor field is new. We are only at the threshold of a revolutionary new structure in the electronics art. A substantial, continuous and accelerated flow of new semiconductor devices from the laboratory into the market over the next five year period is anticipated.

While the application to radio and conventional electronic devices will be substantial, there may be an overwhelming rash of applications in fields never before exploited in an electronic sense. The breadth of transistor applications should exceed that of vacuum tubes and by 1960, there should be more transistors sold and placed in new equipment than vacuum tubes.

The characteristics of semiconductor devices will be extended. The time will come when we will have new transistor or semiconductor amplifier configurations which will isolate the input from the output, others which will give us high impedance input circuits, some of which will give us very substantial power output, and some really practical devices working at frequencies as high as 400 megacycles and above. Transistors are in the future. You will use them in your homes, offices, factories, trains, automobiles, airplanes, communication systems, and in a multitude of durable consumer goods and industrial gadgets and control devices.



Illustrated are three of the new transistorized Motorola Handie-Talkie portable radiophones. From left to right are: the lightweight maximum portability version including handset-type microphone and standard dry battery power pack; the speaker and microphone version with extra-duty battery power pack or rechargeable nickel-cadmium wet cell-6/12 volt power pack, and the high-powered pack version with rechargeable nickel-cadmium wet cell power pack or extra-duty dry battery pack.



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The United States has become "budget conscious" and the taxpayers are extremely concerned with receiving value for money paid. Economy-minded men at the Bureau of Ships are at work increasing the value of the Naval dollar as it is applied to defense contracts. The following article points to the benefits and potentialities of a "Value Engineering" program as developed by the Navy in the field of electronics.

VALUE ENGINEERING

by S. C. Bregman
SIGNAL Staff

A BRAND NEW CONCEPT CALLED "Value Engineering" is impressively being put to work at the Bureau of Ships, Navy Department. Designed to bring the manufacturer in as part of a defense team working with the military, the new concept emphasizes the "second look" in the design of electronic equipment, including a critical appraisal of Government specifications.

Precisely, Value Engineering is defined as, "an objective appraisal of all elements of the design, construction, procurement, installation and maintenance of an equipment, including the applicable equipment specification in order to achieve necessary function, maintainability and reliability of an equipment at minimum cost." This sounds like a large assignment, but it has a winning, constructive, common sense approach to the problems of outmoded contract specifications.

Specific Examples

During an interview, Mr. Albert Sikorsky, Electronics Assistant to Captain John M. Waters, the Director of Value Engineering, adequately pointed out the necessity for such a study with some rather startling examples of monetary waste. He displayed what looked like an ordinary capscrew, and added that the military was charged $2.11 for it instead of the usual three cents paid for the standard capscrew. The reason—its design was about 3/32 of an inch longer than the standard. This item necessitated special tooling where the standard capscrew would have sufficed. Mr. Sikorsky also showed us a waterproof washer, not as large as a lifesaver, which could be purchased at a local hardware store at the rate of 20 for one dollar. The Navy pays one dollar for one. Why? Because the standard specification requires that it should be wrapped individually for special overseas shipment; and so the small washer is shipped in several foldings of protective paper and metal foil. These are not extreme examples, and even these illustrations of monetary waste can easily be eliminated, once Value Engineering reaches all manufacturers involved in defense contracts.

The problem lies in the fact that the engineer writing the military specifications cannot predict resulting complexities or cost until the physical product is obtained. The contractor, on the other hand, invariably considers the written specification as law though he realizes that it may not give full value to the customer. Therefore, the "second look" at design and specifications provides a two-way outlet for both parties concerned. It involves a feedback information loop from the manufacturer to the Bureau. In fact, it is a Value Engineering study by the contractor. It is intended that changes in specification, resulting from Value Engineering, would be made prior to production, avoiding any changes in the contractor's schedule once the production line is in operation.

Two Main Areas

The Value Engineering program is broken down into two main areas around which it evolves—Research and Development, and Production.

In R & D a thorough study of an experimental model and its governing specification is made by the contractor and proposals are submitted to the Bureau. Too often, in R & D, the engineers are concerned with "making it work" and run too hurriedly over production and material details involved. Engineers making the second study are called the "Value Engineers." Preferably, they should not be the same ones who participated in the product's original design since personal attachment often prevents an engineer from making proposals for change. The background of these Value Engineers should be compre-

hensive; not only should they have a broad knowledge of design, materials, and costs, but they should have the added ability of relating the cost of a design to the production version. Diplomacy in their endeavors to make and sell their proposals is vital because they continually work across many organizational lines. Admittedly, engineers of this caliber are not easily found, however, extra effort in this direction should develop a sufficient number of them in a few years.

In Production, the Value Engineering study is to be made during the pre-production engineering phases of the contract. An incentive is incorporated into this type of contract, i.e., if any saving results, the contractor is allowed a share of that saving. The Bureau pays all costs of the Value Engineering services in both R & D and Production type contracts.

Since maintenance costs are usually many times the cost of the original equipment, the manufacturer may find it necessary to propose an increase in the initial expenditure, but reduce the maintenance outlay. In this case, greater economy is ultimately achieved.

Job-Plan

Stressing efficiency and competence in all facets of Value Engineering, a job-plan has been drawn up that systematically breaks down the operation of the study into phases.

1. *Information phase:* The Value Engineer gathers the most complete and detailed information pertinent to the item. In order to provide adequate background information, the Bureau will arrange discussions with the contractor's Value Engineers on the operational, maintenance, and design aspects of the Bureau's specification. In addition, the Bureau will indoctrinate these engineers with some of the more important techniques of Value Engineering.
2. *Speculative phase:* The creative imagination is given more freedom as new and different materials, processes and procedures are explored. It is in this phase that the hardware is trimmed to necessity.
3. *Planning phase:* The extensive research and imagination synthesize in determining the most advantageous course of action.
4. *Execution phase:* Designs undergo necessary tests and design specialists are contacted. Not only must the item be technically sound, but it must be backed by cost figures and able to "sell" itself.
5. *Reporting phase:* Value Engineering proposals are written and submitted to the Bureau of Ships for approval. They will be acted upon within 30 days, and the approved proposals will be incorporated into the production equipment.

The outlined plan is flexible and is designed to serve as a guide to action without dogmatically specifying procedure. Its systematism indicates the thoroughness with which the idea of Value Engineering was conceived.

Two Obstacles

Before this ambitious goal is realized, two rather sizeable obstacles must be confronted. One is to preserve the incentive during renegotiation, and the other exists in getting the Navy to change present specifications. Both of these problems are understood and are being met by the men at the Bureau. (Hence, diplomacy and salesmanship become valuable aids to the program.)

The Renegotiation Board is expected to publish a statement which will assure manufacturers that their allowed share of the savings will not be refused in renegotiation. In redeterminable types of contracts, such assurances will be provided directly into the Bureau's contract schedule.

In regard to a Value Engineering effort in electronics, the Navy can look to the Army Signal Corps for a precedent, where such engineering studies have been made on a case by case basis, i.e., radio receivers already in use.

It is true that Value Engineering thrusts a new burden on the manufacturer, but not without rewards. A notable example of Value Engineering in the shipbuilding industry is cited when a particular landing craft was reduced in cost from $36,000 to $21,000—no essential requirements cut. The General Electric Company, forerunner in "Value Analysis," reports a multi-million dollar annual savings. Because of such profitable illustrations, industry cannot long ignore the benefit of this program.

An enthusiastic appraisal of the Bureau's Value Engineering program has prompted some private firms to set up Value Engineering in their own plants. One company has established, in each of its defense operating departments, a similar Value Engineering function "for the purpose of reviewing our designs and our manufacturing processes in order to reduce cost." Saluting the Navy leadership in the matter they express "thanks for the stimulation which it has offered in putting such a program into effect."

Similar responses should certainly be forthcoming from all phases of industry participating in the program as the valuable results of industry and Navy, working as a defense team to emphasize function, maintenance and reliability at minimum cost are realized. The whole idea of the Bureau can be summed up as a search for simplicity and value.

The electronics program does not stand alone in this new streamlining process. Similar programs are underway in Naval architecture, marine engineering, electrical engineering and mechanical engineering.

The Future

Those working on the project at the Bureau of Ships are Captain John M. Waters and his assistants, Lt. Commander A. T. White, A. Sikorsky, and R. B. Bussler along with other staff members. Captain W. I. Bull, Assistant Chief of the Bureau of Ships for Electronics, gives strong support and guidance in this effort, and M. L. Roylance, in charge of Value Engineering coordination for Captain Bull, will work with private contractors in the performance of the Value Engineering specifications.

We see a bright future for rapid development of this challenging program. The military, like private industry, seeks an improved, economical streamlined business. The Navy feels that by utilizing the production experience of its contractors, it will accelerate improvements in specifications to provide a more reliable and maintainable equipment, at lower cost to the taxpayer. As several evaluations of the program from industry and defense have observed, "That is GOOD business." Our annotation—it is Common Sense.

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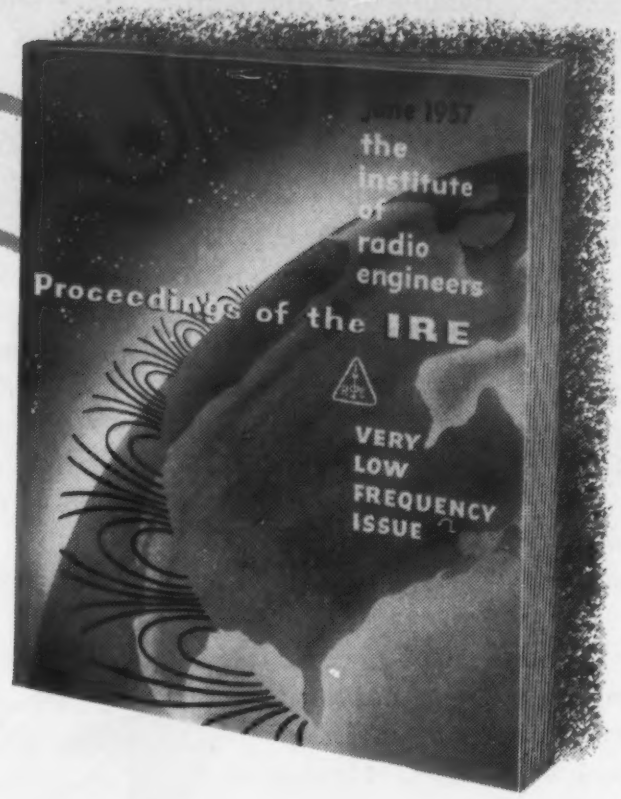

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June Proceedings of the IRE gives you the facts about VLF

This year, the Boulder Laboratories of the National Bureau of Standards and the IRE Professional Group on Antennas and Propagation co-sponsored a Symposium at Boulder, Colorado, on the propagation of very low frequency radio waves. From the papers given at this important meeting the editors of *Proceedings* have chosen those of broadest interest for publication in the June, 1957, issue.

Typical of the service offered members of IRE is this VLF report — to be used now and referred to for years to come. If you are not a member of *The Institute of Radio Engineers* be sure to reserve a copy of the June *Proceedings of the IRE*, today!

Partial Contents of this VLF issue:

"A Technique for the Rapid Analysis of Whistlers," by J. K. Grierson, Defense Reserve Board, Ottawa, Ontario, Canada.

"VLF Radiation from Lightning Strokes," by E. L. Hill, School of Physics, University of Minnesota.

"Some Recent Measurements of Atmospheric Noise in Canada," by C. A. McKerrow, Defense Reserve Board, Ottawa, Ontario, Canada.

"Intercontinental Frequency Comparison by Very Low Frequency Radio Transmission," by J. A. Pierce, Croft Laboratory, Harvard.

"The Mode Theory of VLF Ionospheric Propagation for Finite Ground Conductivity," by James R. Wait, National Bureau of Standards, Boulder, Colorado.

"The Geometrical Optics of VLF Sky Wave Propagation," by J. R. Wait & A. Murphy, National Bureau of Standards, Boulder, Colorado.

"Characteristics of Atmospheric Noise from 1 to 100 Kc/s," by A. D. Watt & E. L. Maxwell, National Bureau of Standards, Boulder, Colorado.

"The Present State of Knowledge Concerning the Lower Ionosphere," by A. H. Waynick, The Pennsylvania State University.

"Noise Investigation at VLF by the National Bureau of Standards," by W. Q. Crichlow, National Bureau of Standards, Boulder, Colorado.

"Reflection at a Shapely-Bounded Ionosphere," by I. W. Yebroff, Stanford University.

"The Attenuation Versus Frequency Characteristics of VLF Radio Waves," by J. R. Wait, National Bureau of Standards, Boulder, Colorado.

"The Waveguide Mode Theory of the Propagation of VLF Radio Waves," by K. G. Budden, University of Cambridge, England.

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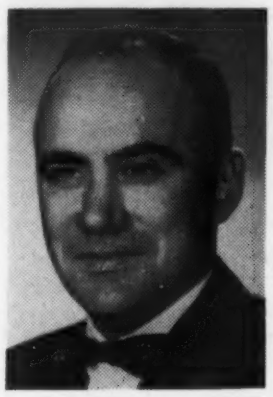
Small Business in The Electronic Age

by Robert Goodman, AEL



Conrad J. Fowler
President
American Electronic Laboratories, Inc.

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THIS IS A BRIEF STORY of how a small business can come into being and prosper in a technical age and an environment of free enterprise. The parameters for success are simple to enumerate: brains, determination, integrity, imagination, a considerable amount of imagination . . . and some money.

While the parameters are simple to state, their utilization is a more difficult matter to discuss. The initiation of a small business in electronics today is not recommended for those who would rely completely on the defense effort nor for those who are not willing to make the necessary personal sacrifices required in the early and painful years of the operation. The future stability and profitable function of a young business today cannot be purchased with money alone. All the other requirements are essential.

In 1948 three of twelve engineers, who were discussing the possibility of setting up an electronic laboratory, discovered that much of their thinking was complementary. These men, Conrad Fowler, Robert Goodman, and Leon Riebman—all members of the Research Staff at the Moore School of Electrical Engineering, University of Pennsylvania—drew together and began to plan an enterprise in earnest. They studied ways and means to raise capital. They investigated reasons for successes and failures of many electronic firms—both large and small. They laid out a skeleton organization which was to be flexible and expandable. They searched for a "jump-off" point so that they and their families would somehow be able to weather the tremendous strain—both financial and emotional which was anticipated. Throughout this period many of the faculty at the Moore School were helpful and sympathetic with their advice and interest. This program of careful study and search continued through 1950.

Late in 1950 an essential "break" occurred. The three young engineers were able to interest John Stern, President of the Radio Electric Service Co. of Pennsylvania, in their plans. Consulting arrangements for one of his enterprises resulted in the establishment of a small laboratory minimally equipped with necessary test equipment. On November 28, 1950, American Electronic Laboratories, Inc., (AEL), was incorporated in the State of Pennsylvania with a capitalization of $500.

For a period of a year thereafter planning, searching, and development progressed. In this period, the workday consisted of doing a thorough job at the University and then going to work at AEL each night and of course, all day Saturday and Sunday. A manpower pool was set up comprised of technical associates and friends who were similarly intrigued with the task of developing a new organization. Technically, this early period saw the beginning of development on an oximeter for clinical use with characteristics generally considered a virtual impossibility at that time.

Starting-Friction

During 1951 the three men concluded that any measure of success in launching AEL could not be attained by chance or part-time effort. They decided to leave the security of the University and bend all their efforts to AEL. The decision made, they left the academic halls behind, bearing with them the good wishes of their colleagues. For months with the help of a part-time staff, they worked at the lab bench building electro-medical research apparatus as products and visiting as many industrial and Government laboratories as possible to find some source of initial income to get them out of the area of "starting-friction." Everywhere, and understandably, the answer to their queries was the same: "We have a winning combination, why should we change or add to our vendors, and particularly with a young company with no history?"

Early in 1952, the Office of Naval Research presented AEL with its first contract . . . a contract based on AEL's own initial development of a new and stable oximeter. The sub-

stance of the problem was to produce an Anoxia Warning System for safeguarding jet aircraft pilots. The confidence of ONR in the integrity and technical ability of a tiny group of engineers was rewarded by a successful demonstration of the electronic device in late 1954. Since that time further refinement has been undertaken and physiological studies are progressing which it is believed will result in not only equipment to safeguard our aircraft crews, but instruments of immense value to hospitals and doctors all over the world. AEL can never forget its first contract nor the significance of the confidence expressed by the technical people of ONR.

The staff at AEL began to grow at this point and by the end of 1952 sixteen men and women were members. Since no time or money existed for errors, all staff members had to be both competent and dedicated. It was further quite clear that dedication and loyalty to any goal could not be bought . . . these attributes had to be earned by management. Since this sort of thinking was completely consistent with the initial planning of the organization and its philosophy, it presented no problem. A clear statement of company policy was written and given to every staff member . . . and every employee, irrespective of his job title, is a staff member. Training groups were initiated to prepare essential technical personnel for management and administrative functions. Objective personnel review methods were designed and incorporated, and organizational information channels set up.

Slowly, by the standards of the staff, and with fantastic speed, by the standards of its fiscal and legal advisors, AEL began to grow. In 1953 sales volume was increased over the previous year by 257%, in 1954 by 9.2%, in 1955 by 52.8%, in 1956 by 157%, and in 1957 it will increase again. In this same period plant area increased from approximately six hundred square feet to twenty-five thousand and total annual sales from approximately $90,000 to $1,500,000. With the help of its bank, the Provident-Tradesmen's Bank and Trust Company as represented by a responsible Vice President, Mr. F. J. Hermann, enlightened financing along with cooperative federal agencies eased the fiscal path of what was now a dynamic operation. Through stringently planned internal controls and thoroughly understood operations, the necessary links between the financial sources and the technical ends of the operation were maintained. Finally, with the aid of the progressive and reputable investment banking house of Spencer Trask & Co. of New York, AEL moved firmly into normal banking channels.

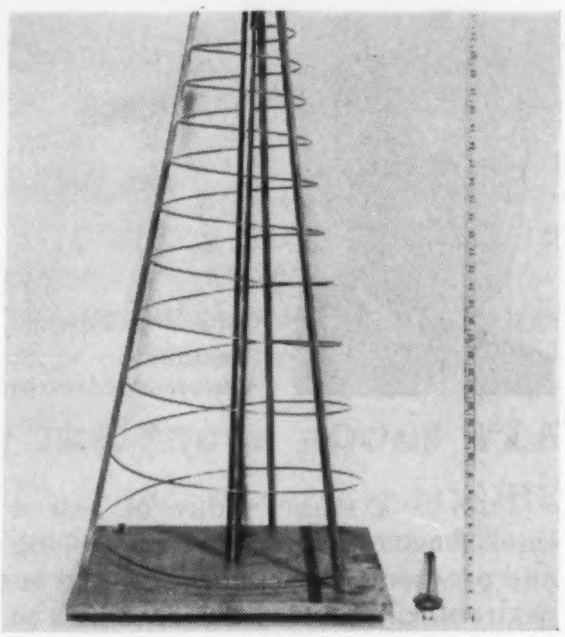
Expansion

In this period it was also recognized that a narrow technical specialization could lead to disaster and a poor balance between production and engineering could be equally hazardous. These observations again fitted neatly into the original organizational planning: "no field of endeavor is foreign to the operation so long as *the staff is competent* in that field and so long as expansion into that field will *not adversely effect the stability* of the overall operation."

Careful planning, a fine staff, excellent advisors, successful productivity, and a certain amount of good fortune have brought a staff of about 150 untiring men and women to the year 1957, a year in which AEL is actively engaged in:

- the manufacture of a growing line of precision instruments for the medical researcher, instruments which are being used all over the United States and a dozen foreign countries.
- the manufacture of a line of unique communications and industrial test gear from pulse generators to high-powered transistor curve tracers.
- the initiation of manufacture of a line of advanced clinical apparatus for universal sale.
- the establishment of a complete external sales organization network through manufacturers' representatives covering the entire United States.
- continuous specialized production and technical subcontracting to key industries for the Department of Defense.
- direct prime contribution of technical know-how and production effort to our Defense Establishment in the fields of antenna design (from LF to over 40,000 Mc), countermeasure total systems, solid state studies, microwave devices, control systems, specific computers, detectors of various kinds for human safety control, etc.
- environmental evaluation of electronic components in its own completely equipped laboratory.

None of these pleasant advances in operation have lulled either the management or the staff at AEL into a sense of well being. The environmental economy and technology is dynamic. Continued existence, growth, and profitable return for staff and shareholders alike will be based on the zeal to plan . . . to discover . . .to know . . . and to move quickly and decisively. Some typical examples of the results of teamwork and planning are the tapered conical helix which represents a basic advance in specialized antenna design, the coaxial crystal detector mount—a remarkable improvement in crystal holder efficiency, the Anoxia Warning System—the most stable photo-electric oxygen saturation detector yet built, etc. All these devices represent true contributions to the Government and industry alike.



Conical Helices—Early development models illustrating possible size variations, 36 inches compared to 4.5 inches.

Defense and Creativity

At AEL it is believed that all industry has a responsibility not only in its contribution to the Defense Effort, but in its general creativity for the specific welfare of people everywhere. These are not idle words of the idealist, but represent a good part of the driving force behind a dedicated staff. This philosophy properly oriented has attracted the support and enthusiasm of AEL's financial sources, shareholders, advisors, and customers alike. AEL has few, if any, customers who doubt either the integrity or competence of the operation.

In this dynamic era of atomics and electronics, it is our unshakable conviction that small business can come into being and grow. The road is difficult and the essential parameters for success must be carefully administered. In the final analysis, the decency, intelligence, and determination of the people involved will write the story of failure or success. Free Enterprise is a difficult taskmaster and no compromise with mediocrity is possible.

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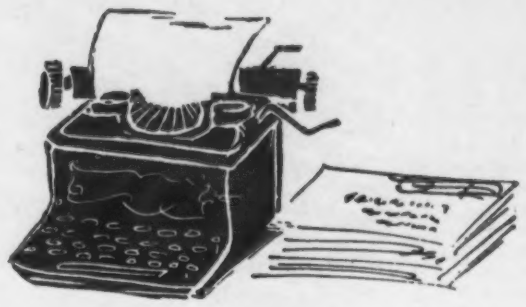

Our Readers Write

SIGNAL Magazine

DEAR SIR:

I wish to thank you for the copy of your very fine magazine, containing the article on our safari to A.E.F. It was a fine article and much appreciated. I only wish that it had all come true. By now, I'm sure you must have learned that my DC-3 flight had to be cancelled out at Gander due to very adverse weather conditions. The two lads I had asked to fly the ship over for me were brokenhearted, of course, because they had to turn back, but they ran into conditions that were pretty rough.

The rest of the safari went off amazingly smoothly. Air France carried us to Fort Archambault and I flew General LeMay from there to our camp 120 miles due east on the Aouk River in the helicopter.

The Eldico equipment worked beautifully and, with it, we not only kept in daily touch via RCA Communications on Long Island with our CBS network, but also kept the 20-meter amateur band humming and kept General LeMay in constant touch with his own outfit.

We also carried three 2-meter Gonset Communicators with us with which we were able to keep in constant touch with the base camp from the helicopter. The third one was carried by one of the jeeps when it was out in the bush and helped us to keep in daily contact with it by 'copter.

All in all, the safari was a tremendous success and proved the efficiency of low-powered high-frequency communications.

Thanks again very much for your kindly interest.

Most sincerely,
ARTHUR GODFREY

The following is an extract from a letter received from Ray Meyers, Lockheed Aircraft Corp., Burbank, Cal.

"Just received the April issue of SIGNAL and must congratulate you on the first item published—*Radio Interference.* We have a number of top flight people in our Cooperative Interference Committee (CIC) that are prospective members of AFCEA and wonder whether or not you have a limited number of extra copies of the April issue that could be mailed when I arrive for the annual Convention in D. C."

Note: Ray, who with Al Parker initially developed the CIC in 1954 in Southern California, did contact us at the Convention and we had the magazines. He mentioned that many requests had been received for his chapter's 1957 brochure on CIC as a result of the "Radio Interference" article. Ray also mentioned that anyone could contact him direct if in need of advice or for a copy of the brochure (717 Anderson Way, San Gabriel, Calif.).

Added Note: During your editor's conversation with Mr. Meyers, we talked about the formation of an AFCEA National Headquarters "Ham Radio Net." Ray produced his card-call letters W6MLZ, and being a first booster for this idea, he sees a great future benefit for such an organization.

In a subsequent issue of SIGNAL, it is your editor's idea to enlist the aid of Mr. Meyers, Mr. George Bailey and other prominent "Ham" operators in the formation of an active "Ham Operators Net." The possibilities are unlimited and a great contribution can be made to Civil Defense and the National Security in peace and cases of emergency.

If you are a "Ham" operator, why not send in your card or call letters while awaiting further details. Even your comments would be of value. Mail to : Editor, SIGNAL, 1624 Eye St., N.W., Washington 6, D.C.

DEAR SIR:

I have to acknowledge, with thanks, your letter of May 14th with which you enclosed the May convention issue of SIGNAL magazine.

I found it most interesting reading and feel very privileged that I was given the opportunity of contributing to it in some small way.

I am sure it will meet with tremendous success and you and your staff are to be congratulated on a very excellent publication.

Yours very sincerely,
D. F. BOWIE
President
Canadian Overseas Telecommunications Corp.

TUBE DEPENDABILITY is vital in this SAGE computer—only a small part of which is shown. IBM engineered and built the huge computer, to operate as the heart of the Semi-Automatic Ground Environment air defense system.

7329 G-E 5-Star 6414 tubes in IBM SAGE computer show no opens, shorts, or mechanical defects!

AFTER 3000 hours' operation, no shorts, no opens, no mechanical defects—this describes all 7329 General Electric 5-Star 6414 tubes in IBM's first XD-1 computer for the experimental sub-sector of the USAF SAGE system.

In contrast: 17% of removals of another twin triode of earlier design tested in this giant computer, were for one of the three reasons above, any one of which can render a tube inoperative!

Uniformly reliable, the 6414 and other G-E 5-Star computer tubes also have heavy-duty construction that wards off vibration and shocks encountered in military field service. Design features of these 5-star types include special compact, sturdy cages; double mica spacers; a double-staked getter.

General Electric helped pioneer high-reliability tubes . . . was first to design, build, and test special tubes for computers . . . later, developed the first computer types with 5-Star high-reliability performance.

The three G-E 5-Star computer tubes, and 32 G-E 5-Star types for communications and other military applications, offer equipment-builders a choice backed by manufacturing experience not found elsewhere. Ask for a G-E tube sales representative to call! *Receiving Tube Department, General Electric Company, Owensboro, Ky.*

Progress Is Our Most Important Product

GENERAL ELECTRIC

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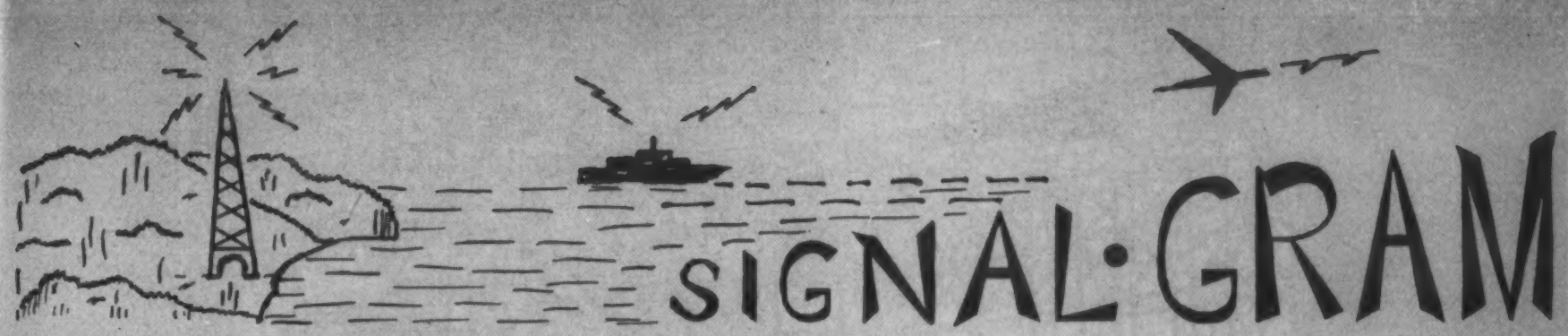


— GOVERNMENT —

"SATELLITE" BASE AT BEALE Beale Air Force Base, California, is the location of the first West Coast "satellite" base for the Strategic Air Command. A 12,000 foot runway, one of the Nation's longest when completed, is included in the $13 million construction job. Other projects consist of new permanent-type building, a control tower, taxiways and warm-up aprons, blast pads and concrete overruns, plus a water distribution system. A squadron of B-52 "Stratofortress" jet bombers and supporting KC-135 refueling aircraft will be stationed at the base as part of SAC's dispersal program. Additional uses are also being considered for Beale such as assignment of Air Defense Command and Military Air Transport Command units.

RADIO "HEARS" INVISIBLE STARS The Navy Department and Bendix Aviation Corp., announced jointly that radio equipment, so sensitive it can "hear" invisible stars, is in production by Bendix to track the first man-made moon. The ultrasensitive radio called "Minitrack" was designed and built originally by the Naval Research Laboratory to track an earth satellite. Along with 11 other receivers under construction by the radio division of Bendix in Baltimore, the "Minitrack" system will be strategically placed up and down the American continents to tune in radio beams from the man-made moon as it orbits in space sometime during the International Geophysical Year. Such sensitive equipment can listen to radio "noise" originating on the sun and detect presence of stars that emit no visible energy.

ARMY TRAINS "INSTRUMENTAL PILOTS" Approximately 440 rated pilots are undergoing training in an eight-week course in order to qualify as Army "instrumental pilots." The instruction, conducted in five continental Army Areas, parallels the instrument flight training course given at the Army Aviation School, Fort Rucker, Alabama. Each student receives 80 hours of first-pilot instrument flight instruction and participates in 180 hours of associate ground school instruction. Four civilian aviation firms are contracted to offer the instruction at five separate airfields.

TACTICAL SUPPORT CENTER The Tactical Support Center (TSC), a new vehicle-mounted communications system, has been developed for the Army in order to give commanders in nuclear-age combat instant control over dispersed tactical support elements. The need for such Centers has grown out of the complex nature and rapid movement of modern warfare which produces problems of liaison between such tactical support elements as artillery, electronic warfare, tactical air support and antiaircraft. The TSC allows a field army commander to weld his highly mobile support forces into a coordinated, power-packed team. Already providing for use of nearly every available communications medium, the concept plans to incorporate an electronic computer into the Center so that target information, priority and selection can be calculated instantly.

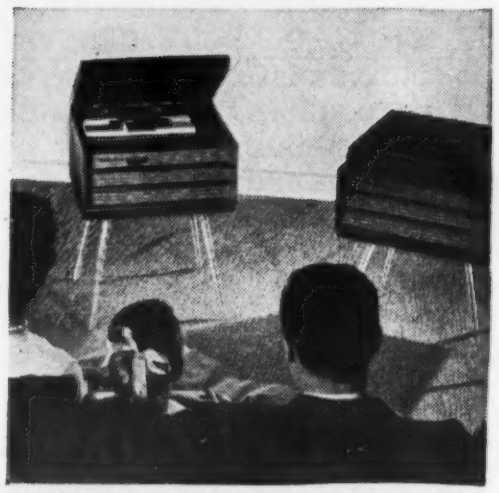
AIR FORCE ORDERS AIRBORNE "BRAIN" An airborne brain that coordinates a supersonic aircraft's whole "nervous system"—receiving and acting upon all atmospheric information necessary for supersonic flight—has been ordered in volume by the Air Force from Bendix Aviation Corporation. The brains, called "Central Air Data Computers," are compact and will be installed on Republic's F-105 and McDonnell's F-101B. Bendix officials explained that the many complex automatic systems responsible for effective operation of a supersonic airplane require various types of highly accurate information about the air through which the plane is flying. The Air Data Computer calculates and distributes this information. It was developed by the company's Eclipse-Pioneer Division in cooperation with the Flight Control Laboratory of Wright Air Development Center.

RCA–First to bring your home the stereophonic sound you've heard at movies

With the development of stereophonic sound by RCA Victor, recorded music and voices achieve depth, direction and realism never before heard in the home.

You hear the music in *perspective*, as in the concert hall—strings from the left, brass from the right. The secret lies in amazing RCA Victor Stereophonic Tape, pre-recorded with two sound tracks. The attractive new RCA Victor High Fidelity Stereotape Player reproduces the sound through two separated groups of speakers . . . gives recorded music new dimensions.

RCA, originator of many other "firsts" in sound, puts this miracle in your living room. And even now, RCA scientists at the David Sarnoff Research Center in Princeton, N. J., are at work in other fields of "Electronics for Living"—electronics that make life easier, happier, safer.



"VICTROLA" Stereotape Player. Two units—tape transport, amplifiers and 3 speakers in one; 3 speakers in other. 8STP2. Both, complete, **$350.00**. Available also in matched luggage-styled cabinets at **$295.00**.

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ELECTRONICS FOR LIVING

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"OPERATION SMOKE-PUFF" The first in a series of attempts to establish two-way radio communication by bouncing radio signals off man-made clouds of ionized gas, wholly independent of the vagaries of nature, will be made some time in July in a cooperative project between the United States Air Force and the Nation's amateur radio operators. The project, entitled "Operation Smoke-Puff," was announced by the American Radio Relay League, national association of radio amateurs. Long-distance radio communication has always been dependent upon the varying reflective power of several ionized layers in the upper atmosphere. Now man is attempting to establish an artificial reflecting layer by firing a rocket 70 miles into the ionosphere to release nitric oxide gas.

ARMY RESEARCH AND DEVELOPMENT TO BE STUDIED Research and development needs of the Army for the warfare of the future will be studied for nine weeks at Damariscotta, Maine, starting July 1. Scientists and military personnel will be meeting under the leadership of Dr. Ellis A. Johnson, director of the Operations Research Office of Johns Hopkins University. The agenda will include the effect of atomic weapons on tactics and supply, the tactical refinements required for most effective use of atomic weapons, and many problems of mobility, communications and command associated with atomic land warfare. These considerations will be applied to the requirements of both general and limited wars.

CONTRACT AWARDS The following contracts have been awarded by the AIR FORCE: American Bosch Arma Corp., $5,932,985, for bomber fire control systems and spare parts; General Electric Co., Syracuse, N. Y., $83,000,000 for electronic equipment; Bendix Aviation Corp.'s radio division, Towson, Md., $6,715,977 for radar sets; Lockheed Aircraft Service, Inc., Ontario, Calif., $5,235,704 for inspection, repair, and modification of RC-121 aircraft; Wright Aeronautical division of Curtiss-Wright Corp., $2,500,000 for engineering work on a dual cycle propulsion system. NAVY contracts awarded include: Westinghouse Electric Corp., $8,170,060 to manufacture the main stream propulsion machinery for the nuclear-powered aircraft carrier (CVAN); Bath Iron Works, $44,045,600, for the construction of guided missile destroyers DDG 952 and DD 953; New York Shipbuilding Corp., $49,123,500, for construction of guided missile destroyers DDG 954, 955, and 956; Martin Co., $24,000,000 to modernize 80 P5M-1 Marlin anti-submarine seaplanes; Sperry Rand Corp. (Sperry Gyroscope Co., Div.) $168,419, for navigation computer and compass pictorial deviation indicator. ARMY grants include: Dynamic Electronics-New York, Inc., $89,273 for 23 antennas type AS-541; Stromberg-Carlson Co., Rochester, N. Y., $49,500 for one light aircraft data link system; Western Electric Co., Inc., $432,500 for additional services, facilities and materials for twelve months to continue study related to transistors and transistor-like devices and associated components modification.

— INDUSTRY —

SODIUM REACTOR EXPERIMENT The Atomic Energy Commission has announced that self-sustaining nuclear fission was achieved in the Sodium Reactor Experiment, a small-scale experimental civilian atomic power project being developed for the AEC by Atomics International, a division of North American Aviation, Inc. This is the first sodium-cooled "thermal" reactor to produce a sustained nuclear chain reaction. The SRE uses neutrons moderated with graphite to sustain the fission process; liquid sodium is circulated through the reactor core to remove heat produced by the atomic fission. Although the design capacity of the SRE is 20,000 kilowatts of heat, during the initial start-up test the reactor operated at a power level of only one kilowatt of heat. No electricity was generated. Future tests will be made to determine the nuclear characteristics of the reactor and to establish the satisfactory operation of all reactor components. The SRE is part of the Commission's program to develop economical civilian power from nuclear energy.

HUMAN LOGIC INTRODUCED IN "ELECTRONIC BRAIN" Engineers at Stromberg-Carlson, San Diego, Calif., plan to build a machine which will enable a human being to tell a computer what to do more often and more easily. A device known as a computer readout and intervention system makes possible the introduction of human logic midway in a problem's computation into the intricate functioning of an "electronic brain." The first readout system, to be produced for Eglin Air Force Base, Fla., will consist of four pieces of equipment for installation: a logic console, a high speed camera recorder, a visual display console, and a Flexowriter. The operator of the computer can watch results of the computation and can intervene directly to feed supplementary instructions by means of the Flexowriter.

HELICOPTERS USE "ELECTRONIC ROAD MAPS" Flying by means of "electronic road maps," helicopters can now operate completely on instruments in cities, the open country, or in remote areas, "regardless of weather and visibility" according to flight demonstrations by Bell Helicopter Corp. and the Pacific division of Bendix Aviation Corp. A "self-contained instrument landing system" provides pilots with necessary information enabling them to take off, fly to any spot inside a 100-mile area, make an instrument approach to within 10 feet of the ground and land without looking outside the helicopter cabin. Thus, a new accuracy and efficiency is predicted for the rural and military functions performed by the helicopter.

HI-FI IN PUERTO RICO Hi-Fidelity, Inc., has opened a new plant at Playa de Ponce, Puerto Rico, installing a new low cost production process. The new process uses pure vinyl powder and electrically-heated molds, eliminating performed, compound blanks, steam heaters, and high-pressure hydraulic presses, it is reported. The company, with its own plating facilities, is manufacturing seven and twelve-inch records, complete from master to finished product, from tapes supplied by the record companies. John O'Sullivan, President, announced that it will press four to five million hi-fi disks annually for big U.S. independent record labels.

SUPER-RADARS REVEALED A long-secret class of super-radars, in service with the fleet for guidance for its Terrier missiles, has been recently revealed by the Navy. Developed by the Sperry Gyroscope Co., the radar antennae have been the subject of speculation since first displayed aboard the guided missile cruiser USS CANBERRA (CAG2). The two SPQ-5 systems aboard the CANBERRA combine many automatic functions in each unit, including the flexible modes of scanning the air space many miles beyond the horizon. Individual targets can be selected from close-flying groups and traced at great distances while the missiles are launched and guided with "extreme accuracy." The massive, turret-like antennae, which resemble gigantic searchlights, have radically changed the contours of the Nation's fighting ships.

NEW AMERICAN-BRITISH ELECTRONICS FIRM Organization of a new Company to manufacture transistors and other semi-conductors in England, through the joint efforts of Philco Corp. and The Plessey Co. Ltd. has been announced by Philco Corp. in the United States and The Plessy Co. in London. The new firm, known as Semiconductors Limited will be licensed under Philco semi-conductor patents. Philco Corporation and Philco (Overseas) Limited will furnish technical "know how" and design information, while supervising the new Company's technical programs. The former will also supply the equipment for the mass production of transistors, similar to equipment installed in Philco's new transistor plant at Spring City, Pa. The joint enterprise establishing the British-American Co. was undertaken following a comprehensive survey of the electronic industry in the United States. Production will begin early in 1958, and the initial schedule is expected to be increased sharply within a few years.

FIRST U.S. AIRFRAME PRODUCTION AUTOMATION SYSTEM The first airframe production automation system to be built in the United States has been announced jointly by the Martin Company and Bendix Aviation Corp. The new milling unit is an electronically controlled machine tool that will substantially reduce "lead time" in the production of military planes and missiles. Built to specifications for Martin by the Research Laboratories division of Bendix, the new manufacturing system uses electronics to transfer coded information from a blueprint to tape. When the information is "read," the 50-ton milling machine is actuated and automatically turns out finished, precision-built aircraft and missile structural parts.

A LAMP THAT WILL BURN FOR A HUNDRED YEARS An electric light bulb expected to burn at least until the year 2057 has been lighted at the General Electric Research Laboratory by Ralph J. Cordiner, GE president. The bulb is a replica of Thomas Edison's first practical lamp which burned for 40 hours in 1879, and is said to have ushered in the modern electrical era. GE has placed the bulb on a desk used for many years by Edison. New materials and manufacturing techniques have made this lamp possible, and a special power source ensures day and night operation of the light throughout its anticipated century-long lifetime.

ELECTRICAL EQUIPMENT FOR LOW TEMPERATURES Extremely low temperatures are among the problems confronting suppliers of electrical systems for DEW line and White Alice projects in the Northwest. Hughey & Phillips, Inc., Burbank, California, one of the suppliers, have engineered and fabricated ready-to-install kits. Among the systems designed to function at extremely low temperatures are sleet control circuits, obstruction lights, lamp failure alarm systems and emergency telephone circuits. Delivery of these "top of the world" communication components is now reaching completion.

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CONTRAVES ITALIANA S. p. A.

ROMA

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GUN FIRE CONTROL SYSTEMS

GUIDED MISSILES

ANALOG COMPUTERS

SERVO MECHANISMS

MEASURING INSTRUMENTS

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TELEPHONE SERVICE BETWEEN THE U.S. AND VIET-NAM Telephone service is now available between the United States and Viet-Nam, the Long Lines Department of American Telephone and Telegraph Co. has announced. Telephone calls to Viet-Nam will be routed through Japan by radio. The distant terminal is located at Saigon, the Viet-Nam capital. Exclusive of tax, the rate for a three-minute call to Viet-Nam from any point in the United States is $15.

PRODUCING AIRCRAFT WITH NEW "EXPLOSIVE TOOLS" Lockheed scientists have set their sights on a new manufacturing target—how to produce aircraft with the aid of new "explosive tools." Due to constantly increasing speeds, aircraft require high-strength, heat-resistant, absolutely smooth metals to thwart the thermal thicket and insure stability in flight. Explosives may provide an answer for shaping the hard difficult-to-form metals into complex contours devoid of riveted attachments. Such an "explosive-forming" method involves socking metal with forces from shock waves traveling 18,000 miles an hour. Gunpowder, one of the cheapest, most powerful and easily controlled sources of power is being investigated along with a .22 caliber rifle cartridge and an eight-gauge shotgun shell. At Lockheed's Burbank plant a small group of men is working on the explosive-forming development project. Their laboratory is a concrete bomb shelter left over from World War II.

— GENERAL —

ACCELERATOR MAY ARREST CANCER A 6 million-volt medical linear accelerator at Stanford University Medical School, San Francisco, is being used in an attempt to arrest cancer. The first report shows that 48 out of 74 patients had tumor growths completely removed. The machine, designed especially for cancer therapy, has overcome a major technical problem; by pumping the vacuum out once and sealing it off, the need for a constant pumping system has been eliminated. The machine was built under the direction of Prof. Edward L. Ginzton, director of the microwave laboratory, and Dr. Henry S. Kaplan, head of the medical school's radiology department. Although it is capable of doing both electron and x-ray therapy, only the latter has been tried. The electron phase is expected to begin soon.

VALUE STUDY OF TRADE SHOWS Alarmed at the rising number of electronics industry exhibits and trade shows, a committee of the Radio-Electronics-Television Manufacturers Association decided to conduct a study in regard to their effectiveness and utility. The study began when the association's trade show survey committee sent a questionnaire to RETMA members asking the number of trade shows in which they could have participated and those in which they did take part during 1955 and 1956. The survey expects to uncover the cost of these exhibits to the manufacturer and form an opinion as to the value of the trade shows.

GOLDEN ANNIVERSARY OF MILITARY AIRPOWER The New England celebration of the Golden Anniversary of military airpower will be held at Hanscom Field, Bedford, Mass., on Saturday and Sunday, June 22 and 23. Feature attraction during the flying part of the program will be the appearance of the world's finest jet precision flying team, USAF "Thunderbirds." In their demonstration, they will fly through every known maneuver at speeds up to 700 miles per hour. Ground displays in four big hangars at the base will supplement the flying show. The event is co-sponsored by the Massachusetts Wing of the Air Force Association and the Air Force Cambridge Research Center.

MUTUAL TELETYPE EXCHANGE A mutual teletype exchange at Chicago has simplified the complicated business of interline reservations for American Airlines and United Air Lines. Reservation information between the two is exchanged via direct teletype message transmission, reducing processing time by shortening telephone calls, and by eliminating relay of reservations information through intermediate offices. Now, the agent simply sends a message via his company's teletype system to the mutual teletype exchange where it is automatically relayed to the communications equipment of the other airline and transmitted to the desired city. Space is confirmed in the same manner.

SOCIETY OF MOTION PICTURE AND TELEVISION ENGINEERS The 81st Convention of the Society of Motion Picture and Television Engineers, held last month at the Shoreham Hotel, Washington, D. C., was attended by approximately 700 persons. More than 100 technical papers covering almost every aspect of motion picture and television science and industry were presented at 14 sessions. A Videotape Recording Session and a demonstration at Walter Reed Army Medical Center of closed-circuit television equipment, highlighted by an explanation of the microscopic camera that opens up the field of the subvisual, attracted considerable interest.

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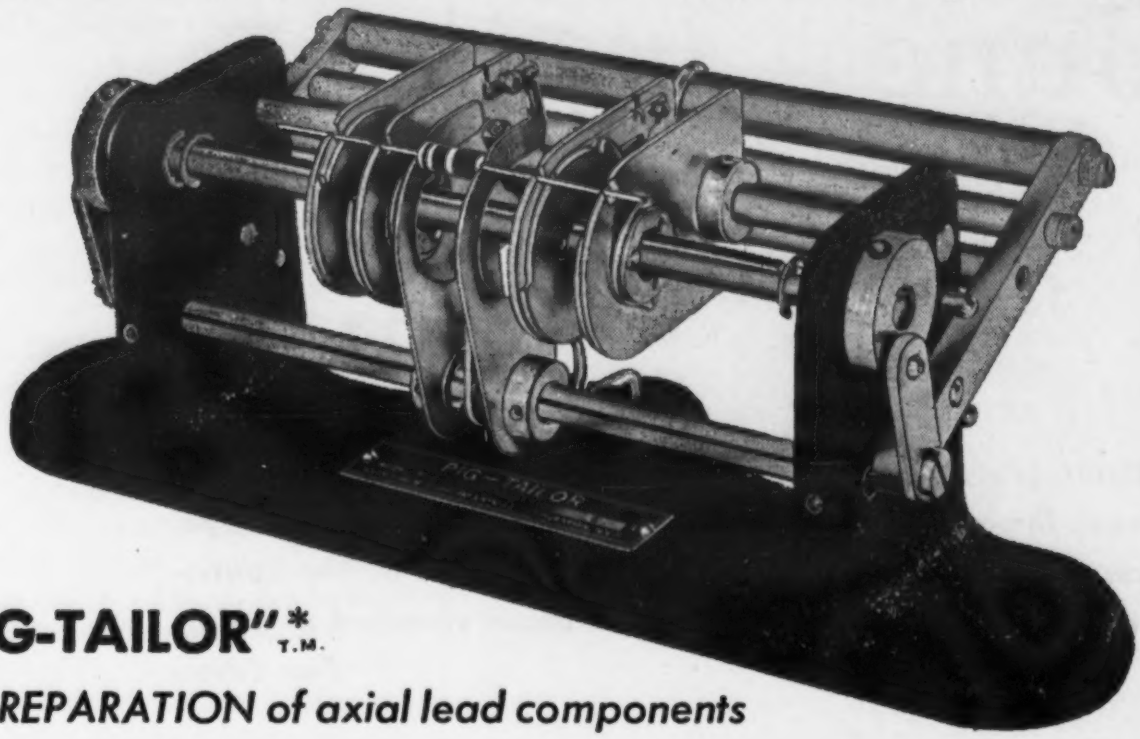
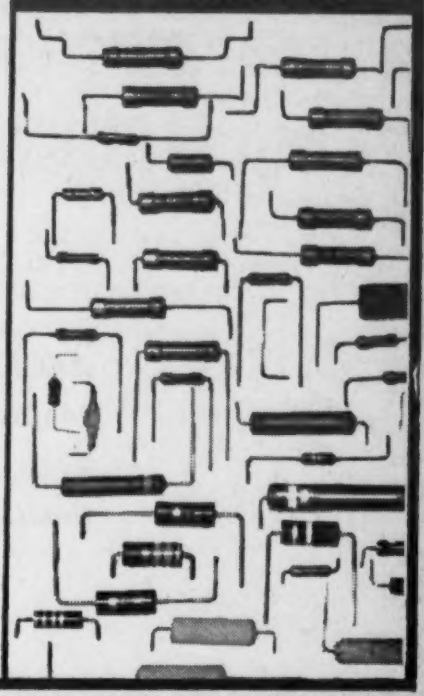
PROVEN-on the assembly line!



"PIG-TAILOR"* T.M.

For PREPARATION of axial lead components

PREPARED COMPONENTS IN SECONDS WITH THE "PIG-TAILOR"



"PIG-TAILORING"

. . . . a revolutionary new mechanical process for higher production at lower costs. Fastest PREPARATION and ASSEMBLY of Resistors, Capacitors, Diodes and all other axial lead components for TERMINAL BOARDS, PRINTED CIRCUITS and MINIATURIZED ASSEMBLIES.

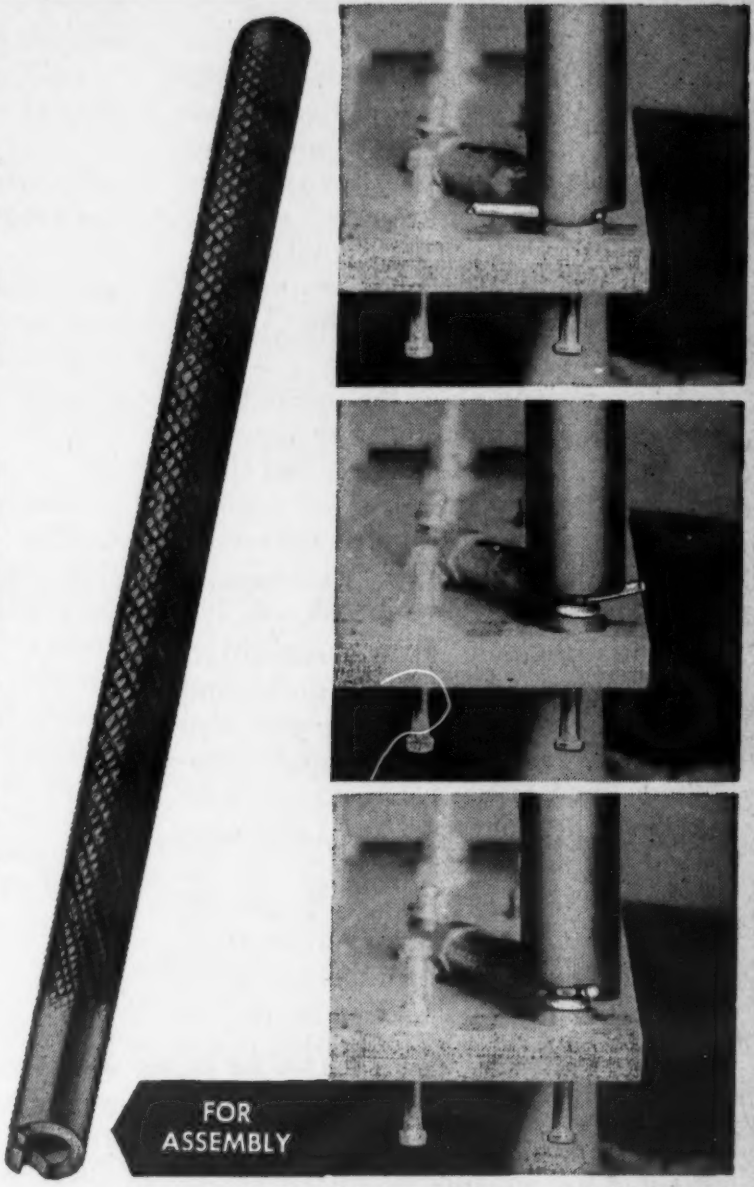
The "PIG-TAILOR" plus "SPIN-PIN"—accurately MEASURES, CUTS, BENDS, EJECTS & ASSEMBLES both leads simultaneously to individual lengths and shapes—3 minute set-up—No accessories—Foot operated—1 hour training time.

PIG-TAILORING provides:

1. Uniform component position.
2. Uniform marking exposure.
3. Miniaturization spacing control.
4. "S" leads for terminals.
5. "U" leads for printed circuits.
6. Individual cut and bend lengths.
7. Better time/rate analysis.
8. Closer cost control.
9. Invaluable labor saving.
10. Immediate cost recovery.

PIG-TAILORING eliminates:

1. Diagonal cutters!
2. Long-nose pliers!
3. Operator judgment!
4. 90% operator training time!
5. Broken components!
6. Broken leads!
7. Short circuits from clippings!
8. 65% chassis handling!
9. Excessive lead tautness!
10. Haphazard assembly methods!



"SPIN-PIN"* T.M. Close-up views of "SPIN-PIN" illustrate fast assembly of tailored-lead wire to terminal.

* PATENT PENDING

Write for illustrated, descriptive text on "PIG-TAILORING" to Dept. S-6P

BRUNO-NEW YORK INDUSTRIES CORPORATION

DESIGNERS AND MANUFACTURERS OF ELECTRONIC EQUIPMENT

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It's June

I'm 97

AFCEA extends greetings to the Army Signal Corps and its leader, Major General James D. O'Connell, on the occasion of the Corps' 97th Anniversary. The following article tells of some of the contributions of the Army Signal Corps to the American standard of living.

The Editor

BENEFITS TO THE CIVILIAN economy of America, ranging from increased airline safety to tiny hearing aids, and the world's finest and most advanced military electronics and communications equipment, have sprung directly from research and development by the Army Signal Corps. The Corps has also made major contributions to improving the American standard of living.

A prime example is the printed circuit, and a companion development known as the "Auto-Sembly" of electronic parts. Inexpensive and rapidly produced, it is now almost universally used in the chassis of commercial radios and television sets.

Civilian benefits of the printed circuit are not confined to radio and television. Such circuits are also basic in highly complicated computers, numerous electronic sub-assemblies, hearing aids, and other electronic equipment.

Based on conservative estimates, annual savings to the Government on defense equipment production alone have passed the $4 million mark. At the present acceptance rate this figure may reach $30 million annually as automated electronic assembly or the Auto-Sembly process continues to be adapted to greater numbers of defense equipments.

Civilian Savings

In civilian electronic production too, acceptance of this revolutionary production technique, now in the public domain, has been virtually universal. Annual savings today of upwards of $3 million revert to the consumer as improved and less expensive devices for every day living.

Designing the light, compact and rugged equipment necessary to modern war, engineers of the Army Signal Corps have worked unceasingly in the field of miniaturization to reduce the size, and at the same time increase the reliability of electronic parts and components. All of these technical improvements have been or will be applied to various types of commercial equipment available to the public.

Hearing aids, as well as miniature civilian radio receivers, use transistors instead of vacuum tubes, not only to save space and weight but to reduce power requirements and thereby battery size. Even smaller and more reliable pocket radios and near-invisible hearing aids will soon result from current developments of the Army Signal Corps in the miniaturization of capacitors, resistors and other electronic parts.

Indispensible in miniaturized electronic equipment and medical instruments are small, efficient batteries. The Army Signal Corps is largely responsible for the design and development of an entire family of tiny reliable batteries—such as the mercury, zinc-silver-oxide and nickel cadmium cells. Laboratory research has prolonged the expected life of nuclear batteries to many years and ordinary manganese dioxide dry cells, used in flashlights and radios, from seven to 35 hours.

Even the complex and highly technical field of frequency control research carried on by the Army Signal Corps has a direct bearing on civilian economy. Successful growth of synthetic crystals has so reduced the price of imported quartz that the crystals needed for precise control in color television receivers now cost about five instead of fifty dollars.

Exact frequency control made possible by the development of precision crystals also opened up the UHF television band in addition to numerous new channels for police, taxi, and other high frequency radios. Combined with miniaturization, precision frequency control has improved civilian aircraft radio performance, thereby contributing to aid safety.

Leader in Radar

As a further move toward increased civilian air safety, the Civil Aeronautics Authority has embarked upon an ambitious program to keep all airliners under radar surveillance at all times. The radar equipment to be used is derived from radar sets designed by the Army Signal Corps for antiaircraft work. These radars have a range of about 200 miles at altitudes up to 80,000 feet.

Long the leader in radar research and development, the Army Signal Corps conceived and developed the storm-detector radar, forerunner of all the weather radars currently being purchased by the Weather Bureau, CAA, Navy and Air Force. This remarkable instrument can spot precisely storm fronts and precipitation up to distances of 250 miles.

The ground control approach (GCA) equipment used by the CAA for bad weather approaches to airports depends largely on magnetron tubes developed by the Army Signal

UMI

Corps. These tubes have another disassociated benefit to civilians. They are utilized in the electronic ovens, latest development in high-speed home and restaurant cooking.

Of importance to civilian defense agencies are the several types of radiation detection equipment designed and developed by the Army Signal Corps. A recent radar technique for surveying and mapping is also useful to civil defense agencies in disaster areas.

In the field of photography, the Army Signal Corps sponsored the design and development of plastic paper that can produce photographs in an oven, eliminating the need for a darkroom. Research also led to the development of an optical image evaluation system that allows camera manufacturers to produce efficient lenses without long trial, thereby greatly reducing camera prices. A 16-mm sound motion picture projector developed by the Army Signal Corps has sparked improvements in both sound and picture quality of commercial equipment. A new 70-mm still camera, designed for combat use, is expected to have wide press and industrial use as a commerical camera.

Ethyl cellulose, developed by the Army Signal Corps, is now the basis for flashlight cases manufactured by at least four commercial companies.

Shock and vibration studies undertaken by the Army Signal Corps in order to devise better packing and shipping methods for delicate electronic equipments provide valuable data to railroads and other transportation media in their efforts to reduce freight damage.

There are many more benefits to the civilian economy resulting from Army Signal Corps research and development. These include portable TV cameras, new and improved techniques of microwave radio relay communication, high-power mechanical rectifiers for the electrochemical industry, miniature thermostats for industrial safety equipment, improved polarized relays for railroads and the shipping industry, internally suppressed spark plugs for automobiles and trucks, better telephone repeaters, improved types of wire and insulation, superior radio and TV vacuum tubes, and a variety of others.

In fact, there is scarcely a single area of electronics or communications that does not in some way reflect the many and diversified contributions of the Army Signal Corps toward improving the American way of life.

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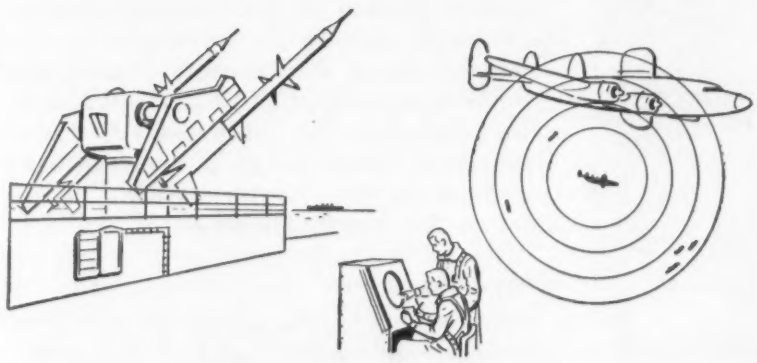

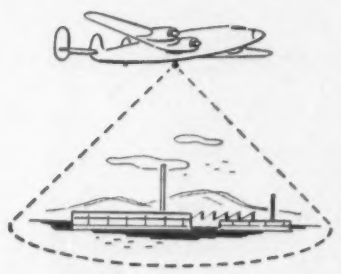

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Chapter News

Arizona

"Energy Freed From the Heavens" was the theme of the bi-monthly meeting held in the Non-Commissioned Officers' Annex, Fort Huachuca, on April 23rd. Guest speaker was B. J. "Ponto" Mealey, Arizona Information Manager for the Mountain States Telephone and Telegraph Company, who presented a lecture—demonstration on the practical uses of the newly-developed solar battery.

"Because of the decreasing supply of conventional fuels, the solar system must be tapped," Mealey declared. An eight-party telephone line in Americus, Georgia, has operated on a solar battery for over a year with no breakdowns, he stated. However, he added that the solar battery is too expensive for general home consumption at the present time.

By subjecting the solar battery to light, Mealey turned a clock motor, amplified his voice from a telephone receiver through a microphone, and played a transistor radio. The solar battery is made of pressed discs of silicon, which is merely sand purified to a fantastic degree. Arsenic and boron gas are added in minute quantities. When light hits the silicon, electric current is created.

Included in the crowd of nearly 100 persons were representatives from Fort Huachuca, Radio Corporation of America, Vicer Aviation Company, Palms Radio Company, Armour Research Foundation, the University of Arizona, American Machine and Foundry, and Hughes Aircraft of California.

Chicago

Henry J. McDonald, Secretary and General Counsel of Kellogg Switchboard and Supply Company, a Division of International Telephone and Telegraph Corporation, was elected president of the chapter at a dinner meeting held at the offices of Illinois Bell Telephone Company on April 25th.

Chicago—Henry J. McDonald is the recently elected president of the Chicago AFCEA Chapter.

Other officers elected for the coming year were: Arthur Schmitt, President of Amphenol Electronic Corporation, vice president; Carrington H. Stone of Carrington H. Stone Engineers, vice president; and James F. Weldon, U. S. Army Signal Supply Agency, secretary.

The following members were elected to the Board of Directors: D. K. Chinlund, General Plant Manager, Chicago Area, Illinois Bell Telephone Company; D. H. Deaver, President, Automatic Electric Sales Corporation; Raymond K. Fried, partner, Feinberg and Fried; Captain H. J. Goldberg, Commanding Officer, Electronics Supply Office, Great Lakes; William Halligan, Jr., Vice President, Hallicrafters Company; John R. Howland, Dage Television Division of Thompson Products, Inc.; Colonel Melvin Kernkamp, Signal Officer, Fifth Army; Colonel Leroy C. Lewis, Chief of Chicago Air Procurement District Air Force; Colonel Arvo N. Niemi, Signal Corps Supply Agency; Dan Noble, Executive Vice President, Motorola, Inc.; W. H. Pagenkopf, Director, Teletype Corporation; L. A. Pereira of L. A. Pereira & Co.; John Huarisa, Executive Vice President, Admiral Corporation and G. R. Haase, DuKane Corporation of St. Charles.

Fort Monmouth—Brig. Gen. Stuart S. Hoff, Commandant, USA Signal School (right), greets Col. Clifford A. Poutré, Sig. Supply Agency, Philadelphia, the chapter's guest speaker.

Fort Monmouth

Colonel Clifford A. Poutré, Deputy Commander, U. S. Army Signal Agency, Philadelphia, was the guest speaker at the April dinner-meeting at Gibbs Hall Officers' Club. His subject was "Electronic Data Processing System as it applies to Logistics Operations within the Army."

The Signal Supply Agency and the Army Signal Corps have been using the system with far-reaching results in speeding delivery of Signal supplies over the world. Colonel Poutré is an expert on the subject.

London

The April 26th meeting of the chapter was held at Taplow Court in Bucks, the home of British Telecommunications Research, Ltd., with its historic associations, where the chapter was given an insight into the activities behind its dignified portal. The chapter is indebted to the group member, Automatic Telephone and Electric Company, Ltd., and to Sir Archibald Gill, Director and General Manager of BTR, for this splendid opportunity.

Louisiana

The March 27th meeting of the chapter was held at Walther Brothers in New Orleans. Special guests of the chapter were Walter Cowan, City Editor, *New Orleans States;* Dr. W. P. Gardiner, Health Director, City of New Orleans; Rear Admiral Joseph A. Kerrins, Commandant, Eighth Coast Guard District; Father Carl Schutten; Charles G. Glueck and W. P. Craddock.

Highlighting the meeting was a talk by past president, C. C. "Bud" Walther, who outlined the progress of Color Television which he then demonstrated by showing the chapter a color broadcast of the Kraft Theatre.

New York

The April 25th meeting of the chapter was held at the Belmont Plaza Hotel in New York City.

The guest speaker was Mr. Ben

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Louisiana—Pictured at the March meeting of the chapter are left to right: Father Benedetto, vice pres.; Dr. Joseph C. Morris, vice pres.; C. C. "Bud" Walther, past president; Charles Pearson, Jr., president, and Rear Admiral Joseph A. Kerrins.

Alexander, Director of the Electronic Systems Laboratory of Federal Telecommunication Laboratories, the research division of the International Telephone and Telegraph Corporation. He explained in a very non-technical manner the events leading up to the development of the "TACAN DATA LINK" which has been developed by Federal Telecommunication Laboratories in co-operation with the U. S. Navy and Air Force. This latest electronic development provides automatic two-way ground-air reporting data links which eliminate the delays inherent in present-day party line radio telephone channels used for air traffic control purposes. He explained and illustrated by appropriate photographic slides how navigation data concerning each airplane can be automatically transmitted to the ground air traffic control stations and plotted upon a radar type scope. By means of pushbutton arrangements ground personnel can transmit instantaneous orders to aircraft for changes in distance, bearing, heading, altitude and speed. The pilot can immediately acknowledge receipt of such ground station commands and initiate reply messages by pressing the proper button on his control box.

One hundred fifteen members and guests attended this meeting.

The meeting was preceded by a social hour and dinner. A meeting of the chapter's Board of Directors was held prior to the meeting.

Northeastern University

The following list of activities has been received from this chapter for the April-June Term.

During April, films shown were "Operations Crossroads," "Origin of Motion Picture," "Naval Photography and Science." Meetings of various groups including Photo and Electronic Groups were held; there were two field trips on helicopter flights, and an address by David M. Owen, Woods Hole Oceanographic Inst., on "Underwater Photography."

During May, films were "Weapons of Artillery," "This is your Army," and "Aerial Fire Power." Activities included the annual banquet which was held at Steubens Vienna Room.

All students interested in knowing more about AFCEA were invited to attend along with members.

Philadelphia

The chapter's April 8th meeting was held in the Skyview Terrace Dining Room at the International Airport in Philadelphia.

The meeting was preceded by a social hour and dinner.

Guest speaker of the evening was Professor Francis Davis, Professor of Physics and Meteorology at Drexel Institute, who discussed Meteorological Measurements. He is well known for his broadcasts and telecasts of the weather over WFIL and WFIL-TV.

Rocky Mountain

The chapter's April 11th meeting was held at the Fort Carson Officers' Club.

The highlight of the evening was a presentation on the "Kitchen of Today and Tomorrow." Mr. G. T. Warren, Supervisor of Kitchen Design, General Electric Company, presented a film on Kitchen Design and its effect on the American way of life. In addition, a short discussion on general kitchen appliances ensued.

Rome-Utica

The Officers' Club, Griffiss Air Force Base was the scene of the chapter meeting on Wednesday, April 10, 1957. Forty members were present for the social hour, the business meeting and a lecture-discussion by Mr. Ernie A. Matson, Jr., vice-president, Technical Materiel Corp. His subject was "Technical Materiel Corp., a Small Business with a Large Future." Mr. Matson discussed the progress of the company, its engineering development, and its production of electronic equipments for the services.

Election of officers was held with the following members selected to serve for the year beginning June 1957:

President: Mr. Allan A. Kunze; 1st vice president, Mr. Murray Socoloff; 2nd vice president, Mr. Charles A. Strom, Jr.; 3rd vice president, Mr. William Roberts; treasurer, Mr. Albert D. Reisenberg; secretary, Mr. Darrell S. Kirby.

New York—Gathered together at the chapter's recent meeting are left to right: Brig. Gen. P. C. Sandretto, USAFR, Federal Telecommunication Laboratories president; Mr. Ben Alexander, the guest speaker; Benjamin H. Oliver, Jr., president of the chapter; Lt. Col. R. R. McMillan, chairman of chapter meetings, and Lt. Col. David Talley, chapter secretary.

CHAPTER NEWS

Sacramento

Captain Les Williams of the California Highway Patrol was the featured speaker of the March 27th meeting of the chapter held at the Sacramento Signal Depot Officers' Club.

He spoke on "The Communication System of the Highway Patrol," explaining how an All Points Bulletin from headquarters reaches the patrol officers.

Darrell J. McConnell of United Air Lines also participated in the program, showing a short color film of Hawaii.

Refreshments and a social hour climaxed the meeting.

Scott-St. Louis

The chapter held its April 5th meeting at Augustine's Restaurant, Belleville, Ill.

The highlight of the evening was a presentation by Captain Walter E. Smith, Assistant to the General Sales Manager of DAGE Television Div. of Thompson Products, Inc. Captain Smith's subject was "Weather-Vision System" which he supplemented with a film showing an operational installation of the system at Grandview AFB, Mo. As the originator of Weather-Vision, he very ably and capably spoke with unquestioned authority on the subject.

Elections were held and brought into office the following: president, Col. Charles W. Gordon, USAF; vice presidents, A. Lisle Lenny; B. Roger Robards; treasurer, Prosper L. Kinsella, USAF; secretary, Allan L. Eisenmayer, USAF; directors (elected for two-year term), Lt. Col. David W. Baugher, USAF; Capt. Paul M. Cowley, USAF; RAdm. Robert E. Melling, USN (Ret.); Walter W. Van Skiver, USAF and Clifford G. Wassall; director (elected for one year, completing unexpired term of Lt. Col. W. J. Trigg) Lt. Col. John L. Jernigan, USAF; directors (with one more year to serve) James G. Blain; Lt. Col. Charles H. Colman, USAF; Harry L. Cooper and Louis E. Dechant.

Tokyo — Dr. N. Tanaka, Nippon Electric Co., was the chapter's guest speaker in March.

South Texas

The April 30th meeting of the chapter was attended by sixty members who heard representatives of the Civil Aeronautics Administration speak on air traffic control. Speaking at Fort Sam Houston, Mr. James Evans, a Senior Controller at the San Antonio Air Route Traffic Control Center, had as his subject, "En Route Traffic Control." Mr. Donald S. Blatchford, Air Traffic Control Consultant described "Terminal Control Facilities and Operation." A short sound film illustrating the traffic control operations was also shown.

Southern Connecticut

The May 16th chapter dinner-meeting was held at the Wonder Bar Restaurant in Bridgeport, Connecticut.

A showing of new developments in the communications art was lined up by the chapter. The display, entitled "Telephone Magic," demonstrated working models of such advanced electronic equipment as solar batteries, micro-wave transmission, transistorized equipment, etc.

Tokyo

"Industrial-Military Relationship" was the theme of the chapter's quarterly meeting held on March 1st at the U.S. Army Signal Supply Center, Far East. Three hundred guests at a buffet luncheon and business meeting heard welcoming remarks by Brig. Gen. Harold G. Hayes, SigO, USAFFE/8 Army (R). Highlighting the meeting was an address on "Microwave Developments" by Dr. N. Tanaka, Nippon Electric Company.

"Exicited by the news from the U.S.A. on the amazing progress in the development of long distant microwave link at AT&T (4000 MC TD-2 System), we started our real research project of microwave links in 1949 utilizing our past experiences," Dr. Tanaka stated. "In this system, several unique technical ideas of which we are very proud were applied. For instance, a microwave repeater uses only one microwave tube, one Travelling Tube, which acts as the receiving and transmitting oscillator and the transmitting amplifier simultaneously, while the broad band microwave repeaters in foreign countries, as regards to one repeater, use more than two microwave tubes usually. This minimization of microwave tubes should contribute to the saving of maintenance cost and the case maintenance."

Afterwards the guests were divided into groups and given escorts through outside exhibits, an electronic repair line and the static exhibits. A total of fourteen Japanese electronic manufacturers were invited to display their equipment. The Signal Supply Center also exhibited various types of Army communication equipment including radar and an ACT vehicle showing the installation of the AN/VRC-30.

Scott-St. Louis—Officers and Directors elected at the April 5th meeting of the chapter are: (seated, left to right) Prosper L. Kinsella, treasurer; A. Lisle Lenny, vice-pres.; Col. C. W. Gordon, president; and A. L. Eisenmayer, sect'y. Directors: (standing, left to right) Lt. Col. D. W. Baugher, L. E. Dechant, Lt. Col. C. H. Colman, Capt. P. M. Cowley, RAdm. R. E. Melling, H. L. Cooper, J. G. Blain, and Walter W. VanSkiver, retiring president.

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Tokyo—Officers view displays at the recent meeting of the chapter which was held at the U.S. Army Signal Supply Center, Far East, Yokohama, Japan.

Washington

The March 29th chapter meeting was held under the sponsorship of AFCEA and the Society of Motion Picture and Television Engineers in recognition of the International Photographic Exposition which was the first of its kind ever to be held in the United States.

Dr. C. J. Staud, the chapter's guest speaker at the Willard Hotel, spoke on "Some Aspects of Photography in Communications and Electronics." Dr. Staud, Vice President and Director of Research, Eastman Kodak Co., said: "Photography by means of pictures has been used on the ground, at sea, in the air to afford intelligence and in that way to communicate information and ideas. . . Those of us concerned with research and development in the photographic field have put forth our best efforts to provide and to afford the highest quality materials and the most suitable processes to facilitate the work of the Armed Forces in their use of this means of communication. Work on the science of photography has been widely applied to the technology as represented by the pictorial, document reproduction, graphic arts, x-ray, and other forms of photography to be of service in a wide variety of fields." Continuing, he spoke of photography's role in recording the performance of guided missiles. He stated: "Schlieren photography and 'shell-burst' photography might be mentioned in this connection. We have therefore been enabled to obtain some general background which is now being turned to use in the more complex and more difficult problems associated with guided missiles traveling at very high speeds and remote from the camera."

Distinguished guests at the head table were Comdr. W. G. Matton, USN, Exec. Off., Naval Photographic Center; Mr. Keith Lewis, Washington Section, Chairman, SMPTE; Lt. Col. R. L. Cochran, USMC, Head of the Aviation Electronics Branch, Div. of Aviation; Mr. E. S. Lindfors, V.P., Bell & Howell Co.; Col. W. W. Lindsay, USA, Chief, Army Pictorial Center, Signal Corps; Dr. C. J. Staud, V.P., Eastman Kodak Co.; M. C. Richmond, president of the chapter; Mr. John A. Whittle, Mgr., Govt. Sales, Eastman Kodak Co.; Col. E. G. Lawton, USA, Asst. Chief of Staff, Intelligence Training Div.; Mr. James E. McGhee, V.P., Eastman Kodak Co.; Capt. C. D. Simonsen, USN (CNO), Air Warfare Div., Head Air Intelligence & Photographic Branch and Mr. H. A. Schumacher, V.P., Graflex, Inc.

The Willard Hotel, Washington, D. C. was again the scene of the chapter's meeting on May 2nd. Rear Adm. Joseph N. Wenger, Director, Communications-Electronics, Joint Chiefs of Staff, presented an especially interesting address on "Teamwork in Military Communications and Electronics and Their Relation With Industry." Adm. Wenger also described the Joint Communications-Electronics Committee organization and the manner in which it functions. In his remarks, he said: "While the JCEC is dealing with a large variety of matters, its major concern is the co-ordination of communications planning and operations. It has long been a basic tenet of the Services that communications are the instrument of command. . . . Accordingly, each Service maintains an essential minimum of Service-operated and controlled communications facilities. These are supplemented by facilities leased from commercial carriers or provided by the other military Services. The Service systems are fully interconnected and mutually supporting. The apparent parallelisms between them suggest unnecessary duplication, but constant effort is made to prevent it."

In speaking of the international aspect of military teamwork, Adm. Wenger said: "For those who may entertain misgivings about three-Service cooperation, let me point to the situation in NATO where the problem has been multiplied by the number of nations involved. With so many different interests at stake, it is a miracle that anything at all has been agreed upon. Yet a vast communications-electronics program is in progress throughout the NATO countries of Europe. There, U.S. and other NATO military Services, working together and with European Civil organizations, are developing the military C & E structure necessary to defend the free world. They are also rebuilding, expanding and modernizing the civil communications facilities to strengthen the economy of Western Europe and provide a vital asset for war."

At the head table for this meeting were the following distinguished guests: Capt. J. R. Dennis, USN, Head, Naval Security Group, OCNO; Maj. Gen. James Dreyfus, USA, Chief, Procurement & Distribution, Office of Chief SigO; Maj. Gen. W. Preston Corderman, Deputy Chief SigO; RAdm. H. C. Bruton, Director, Naval Communications Div., OCNO; Maj. Gen. A. L. Pachynski, Director, Communications-Electronics, DCS/O; Maj. Gen. J. D. O'Connell, USA, Chief Signal Officer; Maj. Gen. F. L. Ankenbrandt, USAF (Ret.); Mr. Percy Black, National AFCEA President; Mr. M. C. Richmond, Pres., Washington chapter; RAdm. J. N. Wenger, Director, Communications-Electronics, JCS; Hon. Dudley C. Sharp, Asst. Sec. of Air Force; Vice Adm. B. L. Austin, USN, Director, the Joint Staff, JCS; Mr. R. H. Hughes, Director of Production, Communications & Mobilization Planning (Asst. Sec. S & L); RAdm. E. N. Parker, USN, Chief, Armed Forces Special Weapons Project; Maj. Gen. A. G. Hewitt, USAF, Director, Maintenance Eng., DCS/M and Mr. Paul Goldsborough, Staff Director, Communications (Asst. Sec. S & L).

ITEMS OF INTEREST
From Government, Industry and the Services

DORSEY NAMED TO SUCCEED CASWELL

Captain Jack S. Dorsey, formerly on duty in the Office of the Chief of Naval operations, has been named Assistant Director, Naval Communications, succeeding Captain Gordon L. Caswell, who retires after 30 years of military service.

Capt. Dorsey has held many key positions in military communications. After top assignments during the war, for which he was awarded the Legion of Merit, he took over the duties of Navy Department Communication Officer, Office of the Chief of Naval Operations. Later, he served for three years as Head of the Communication Department at the Naval Post graduate school, and from 1952 to 1954, was the Chief of Communications, Joint Staff, Commander in Chief, Caribbean. He is a graduate of the U. S. Naval Academy.

Capt. Gordon L. Caswell, a graduate of the U. S. Naval Academy, has served in the Navy for thirty years. He is widely known in the communications field for such outstanding accomplishments as the instigation of a committee, which he chairmaned, to study the art of radio propagation predictions and forecasts; he wrote the present U. S. Navy Communication Instructions which, with only minor changes, is still the Bible of naval communications today.

In 1945, he served as Assistant Communication officer on the Staff of the Commander in Chief, Pacific, where he had the responsibility for the radio frequency and circuit planning throughout the entire Pacific area. His activities in the field of international communications are particularly noteworthy and exceptional. In 1947 he attended the World Conference of the International Telecommunication Union where he headed the U. S. team assigned the task of formulating a new international frequency list. In 1954 he served for four months as communication advisor to the Secretary of Defense, and then assumed his most recent position as Deputy Director, Naval Communications.

Both are members of AFCEA.

NEW SIGNAL CORPS ASSIGNMENTS

New assignments for Army Signal Corps senior officers have been announced by Maj. Gen. J. D. O'Connell, Chief Signal Officer of the Army.

Maj. Gen. W. Preston Corderman, Deputy Chief Signal Officer, will go to Ft. Monmouth, N. J., replacing Maj. Gen. Victor A. Conrad, Commanding General, who has been named Chief Signal Officer, SHAPE, Paris, France.

Brig. Gen. Ralph T. Nelson, now Commanding General of the Signal Training Center, Ft. Gordon, Ga., will become Commanding General at Ft. Huachuca, Ariz. He will be replaced by Col. David P. Gibbs, who is presently Signal Officer of Continental Army Command, Ft. Monroe, Va.

Brig. Gen. William M. Thames, Ft. Huachuca, is to be assigned as Commanding General to the U. S. Army Combat Surveillance Agency, Washington, D. C.

Col. E. L. Littell, Comptroller, Officer of the Chief Signal Officer, will become Commanding Officer, U. S. Army Signal Supply Agency, Philadelphia, Pa. (USASSA).

Brig. Gen. William D. Hamlin, presently commander of USASSA will be assigned to U. S. Army, Europe.

Effective immediately, Brig. Gen. Kenneth F. Zitzman who was Chief, Personnel & Training Division, OCSigO, became Asst. Chief, Combat Development & Operations Division, while Col. W. B. Bess, who was with the P & T Division, became Chief of the Personnel Division.

Accelerometer Measures and "Senses" Speed of Vanguard

A specially designed "integrating accelerometer" is being built by the Dynamics Corporation of America subsidiary, Reeves Instrument Corp., to "sense" and measure the speed of the Vanguard Launching Vehicle for an earth-circling satellite during its second and third phases. It will be able to measure and integrate a satellite's acceleration with an accuracy never before achieved by this type of mechanism.

While the path of the launching vehicle is predetermined and such factors as distance, weight and atmospheric conditions are all taken into consideration before launching, headwinds and thrusts from the rocket motors and the drag from other forces encountered by the flight up to that point, will exert pressures upon the vehicle which cannot be computed in advance. During the second stage of an attempted satellite launching, the Reeves' instrument, by "sensing" and measuring the increasing speed, will detect the uncalculated deviations. This information is needed by a computer to calculate the "coasting time" of the rocket.

The two major parts of the accelerometer are a gyroscope and a pendulum. The "sensing" and measuring device consists of 350 tiny parts most of which have to be assembled by white-robed technicians working under microscopes in an antiseptically clean laboratory.

Mack Electronics Names Director of Engineering

Wendell E. Phillips has been appointed Director of Engineering for Mack Electronics Division, Inc., Plainfield, N. J. He will head all research and engineering activities of the Division which is a subsidiary of Mack Trucks, Inc.

Mr. Phillips has held engineering positions with the Lavoie Laboratories, the Federal Television and Radio Corporation, and Air Associates. He is a member of AFCEA, and I.R.E., and presently serves on the Advisory Committee on Electronics at Farleigh Dickinson University.

(*Continued on page* 42)

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	  ◦ Transmitters
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IGY World Warning Agency

Beginning July 1, 1957, the National Bureau of Standards radio forecasting center at Fort Belvoir, Va., will serve as the focal point of a world-wide communications network for the International Geophysical Year. From this point, warnings will be flashed to scientists throughout the world to redouble their observational efforts.

The warnings will be based mainly on world-wide observations of the surface of the sun and on the soundings of the ionosphere, the electrically charged upper portion of atmosphere. When the surface of the sun erupts, shooting flames for hundreds of thousands of miles, the earth's atmosphere is showered with vastly increased quantities of particles from outer space. The solar bombardment not only causes magnetic compasses to misbehave but also produces brilliant displays of Northern Lights and causes changes in radio communication through its effect on the ionosphere.

In addition to the NBS station at Fort Belvoir, the international network includes the radio teletype network of the World Meteorological Organization, virtually all of the commercial communications facilities throughout the world, government facilities (such as CAA), and special messages broadcast by the NBS radio propagation forecast channels and their counterparts in other countries. No matter how remote the site, IGY scientists can conduct their experiments simultaneously.

A series of Regular World Days has been selected in advance for more detailed simultaneous observations. However, there will be supplementary alerts when major solar-terrestrial disturbances are expected.

The forecasting center in Virginia will also serve as the Western Hemisphere Regional Warning Center. In the U.S. itself, messages will be put on the U.S. Weather Bureau communications system so that each local weather station can inform IGY field stations in its area.

A Bigger "Boom" in TNT

How to put a bigger "boom" in TNT explosions is the secret being sought by scientists of the Navy's Ordnance Laboratory, Silver Spring, Md. Using a giant camera, manufactured by the Beckman Whitley Co., the laboratory's Explosives Research Department is conducting detailed studies of the propagation of small explosions.

The studies aim at finding out where, when, why, and how an explosive explodes, and what happens to the air around it and metals near it. With the information gained, scientists will be able to produce bigger explosions on the part of mines, rockets, guided missiles, and other weapons being developed at the Ordnance Laboratory.

The camera, a striptype, using a revolving mirror to reflect an image through openings onto a film, has electronic devices which precisely control the camera timing and the explosive detonation. The hydraulically driven mirror can make 10,000 revolutions per second. Coupled to a bombproof "doghouse," the camera takes photographs through ports in two-feet thick concrete walls of a blast chamber. The "doghouse" can withstand five-pound explosive blasts.

A new Reserve Unit, the 262nd Signal Co., was activated in a ceremony held in the Office of the Chief Signal Officer. Maj. Gen. J. R. Pierce, Deputy Commander, 2nd Army, presents new guidon to Capt. J. J. Gancie, Company Commander as dignitaries look on. L to R: Maj. Gen. J. D. O'Connell; Mr. B. M. Grimes, Supt. Washington Office, American Cable & Radio Corp.; Maj. Gen. Pierce; Capt. Gancie; RAdm. E. W. Stone, Pres., American Cable and Radio Corp.; and Mr. and E. J. Girard, Asst. Vice-Pres., Federal Telephone & Radio Co.

U.S. Exhibits at Paris Trade Fair

"The Atom and Life" was the theme of the U.S. Central Exhibit at the 46th annual Paris International Trade Fair (Foire de Paris), May 25-June 10. For the third successive year, the United States was represented at the Fair, and this year some 200 American firms had individual displays.

The Central Exhibit gave a practical demonstration of the constructive uses of nuclear energy as applied to medicine and surgery, to agriculture and in factories, homes and power stations. Production of radio isotopes were demonstrated using a 27′ x 18′ actual size animated model of a graphite reactor.

Exhibited for the first time outside of the United States was the only set of electronically controlled "Hands" in the world. The "Hands" are considered to be the most advanced general purpose manipulator thus far developed.

An animated model of one of the power reactors in the U.S. explained how an atomic plant can generate electricity. There were also other exhibits of tools of the atomic age with laboratory equipment, protective clothing, handling equipment, and recording and measuring equipment.

Powerful Radio Transmitter To Be Installed in Pentagon

A powerful new short wave transmitter which can beam vital defense messages to any spot on the earth, even through severe interference, will be installed for Pentagon use, the Army has announced.

Called the World Spanner, the transmitter was designed for use as part of the Army's world-wide communication network by the U.S. Army Signal Engineering Laboratories, Fort Monmouth, N. J., and by Continental Electronics, Inc., Dallas, Texas. Almost 50 times more effective than the loudest commercial broadcasting station, the set owes its tremendous power to single sideband design.

Simplicity and compactness are salient characteristics of the World Spanner. By just turning a single switch, an operator can go on the air at any one of ten previously set frequencies. Despite immense power, it is completely safe to operate.

The World Spanner can transmit at any frequency in the short wave spectrum from 4 to 30 megacycles. A second version will cover the range from 20 to 65 megacycles.

Infantry Division Reunion

The 94th Infantry Division Association, Inc., is holding its 8th Annual Reunion at the Hotel New Yorker, in New York City, July 18-21, 1957. All information can be obtained by writing the Secretary, A. E. Rodriguez, 614 Oakdale Ave., Chicago 14., Ill.

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Air Force Has New Research Aircraft

The United States Air Force has announced progress in development of a new research aircraft. Wind tunnel tests are nearing completion and fabrication of the X-15 rocket-powered research airplane, scheduled to fly higher and faster than any other manned aircraft, has begun at the Los Angeles plant of North American Aviation, Inc., under contract with the Air Force.

Although specifications are classified, the engine's thrust will be greater than the thrust rating of the Air Force X-1 and X-2 series aircraft which Air Force pilots have flown at speeds of more than 1650 miles per hour and altitudes of 90,000 feet or more. New design techniques have resulted in considerable weight and size savings.

The X-15 project was initiated following preliminary studies by the National Advisory Committee for Aeronautics to determine the feasibility of developing a research airplane to extend exploratory investigations beyond the flight regimes of the X-1 and X-2 research aircraft. A coop-program between the Air Force, Navy and NACA was established.

When North American delivers the aircraft, it will be used at the Air Force Flight Test Center in a program of flight research by the NACA in cooperation with the Air Force and Navy Bureau of Aeronautics.

Two Chicago Engineers Win Fellow Awards

Fellow Awards, the electronic engineer's counterpart of the Nobel Prize, have been won by two Chicago engineers. Dr. Rinaldo De Cola, Director of Engineering at Admiral Corp. and member of AFCEA, and Dr. Eugene Mittelman, Consulting Engineer, are the honored recipients of the awards.

The Institute of Radio Engineers annually presents these honors for major contributions to the field of Electronics. Dr. Mittelman was honored for "pioneering in the field of industrial electronics," while Dr. De Cola's award was for "contributions to the fields of Military Electronics and television receivers."

Naval Observatory Under Construction To House Radio Telescope

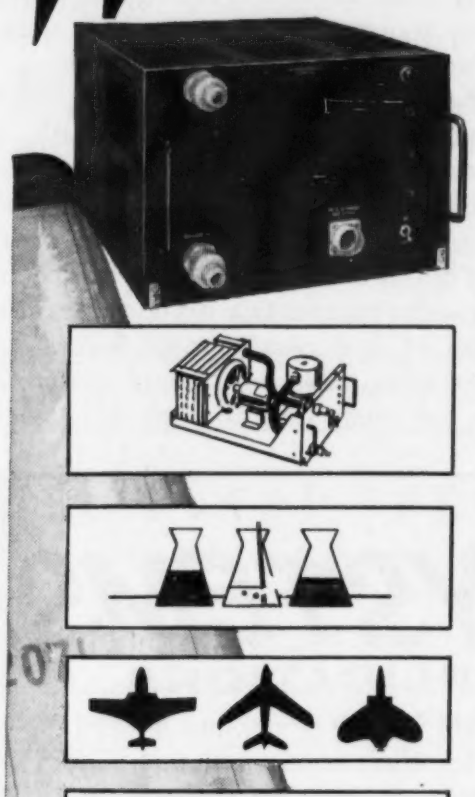
Construction has begun on the Maryland Point Observatory of the Naval Research Laboratory, near Riverside in southern Maryland, the Navy has announced. When completed later this year, it will be the largest radio telescope installation in the U.S. and the largest known equatorially mounted installation in the world.

Designed by the D. S. Kennedy Co., Cohasset, Mass., it will consist of an 84-foot dish-shaped antenna mounted at the top of a large steel supporting tower. The antenna, built primarily of aluminum, will have a precise parabolic surface, permitting investigations of radiations from outer space at wave lengths as short as 10 centimeters. Mounted with one axis parallel to the earth's axis, the antenna permits tracking of any celestial object with a simple clock drive. Thus, the detection of fainter sources of radio signals, as well as a more detailed study of intense sources is made possible.

The Maryland site was chosen because it provides an excellent view of the horizon and low radio interference.

Radio astronomers at NRL will use the new instrument in the continuing program of research on radio radiation from the sun, moon, and planets. They will also carry on studies of the composition and physical processes occuring in interplanetary, interstellar, and intergalactic space.

Who put out the "fire" in the tail?



Hallicrafters ... with a revolutionary, mass produced cooling unit for airborne electronics. Dissipation up to 7,000 watts ... 20% less costly ... 30% lighter.

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Tiny Microphone Placed in Heart Picks Up Heart Beat and Blood Flow

A tiny microphone, so small that it can be passed through an artery or vein directly into any part of the heart, promises to aid heart specialists seeking to diagnose and determine the exact location and extent of heart defects. The development of the heart microphone and the technique of using it has been a joint project of Gulton Industries, Inc., Metuchen, N. J., and Mount Sinai Hospital, N. Y.

The microphone, measuring only 1/20th of an inch in diameter and ¾ths of an inch in length, is inserted into the tip of a standard cardiac catheter and connected by cable to an oscilloscope. Passed into the heart through a vein or through an artery, the device can be manipulated by the physician to the appropriate location. By picking up precise sounds of the heart beat and the blood-flow, the natural inaccuracies inherent in the indirect stethoscope method are eliminated.

Sound energy, picked up by the Gulton microphone shows a visual pattern of heart sounds on the oscilloscope. Trained physicians can interpret the patterns to determine the exact sounds taking place at the point of microphone location within the heart.

A minute diaphragm located in the tip of the catheter is connected to a pressure measuring device which converts blood pressures into electrical energy. These pressures are also shown on the oscilloscope. An electrocardiograph hooked into the circuit shows the physician simultaneous oscilloscopic pictures of the heart sounds, the blood pressures, and the electrical impulses generated by the heart, all of which are of extreme importance in diagnosing the type of heart defect and its exact location.

Two Atomic Combat Army Units

The Department of the Army has announced that two additional U.S. Army divisions, the 4th Armored at Fort Hood, Texas, and the 4th Infantry at Fort Lewis, Washington, have begun reorganization as atomic combat units.

The Pentomic Infantry and Airborne Division—a division with a pentagonal structure, geared to fight under atomic conditions—is the result of studies and actual field exercises conducted by the Army in recent years. It represents a division organization of five combat unit forces incorporating the maximum capabilities for sustained combat, air-transportability, battlefield mobility, and control.

The capability of absorbing new weapons and equipment into the new Army divisions has been developed in their structure. The divisions will have the capacity of rapid concentration, equally rapid dispersal, and increased action during periods of reduced visibility. Increased use will be made of organic and supporting aircraft.

Within the next two years all of the Army's divisions—Infantry, Armored, and Airborne—will be tailored to fight wars in which atomic weapons are introduced, while still retaining their firepower and general effectiveness for successful non-atomic combat.

Britain's Fastest Submarine

Britain's fastest submarine, *Explorer*, is "a strong contender" for the title of the world's fastest submarine. This was announced by the English Parliamentary Secretary to the Admiralty when the *Explorer* was reported to have exceeded 25 knots under water.

Entirely unarmed, the *Explorer* is Britain's first high-test peroxide submarine. Her purpose is to act as a fast target to train the Royal Air Force in the latest tactics against high-speed underwater raiders.

Having a displacement of only 780 tons and an overall length of 225 feet 6½ inches, she is very maneuverable and only the readings on the instruments and a tremor on the depth gauge suggest the high speed.

She differs chiefly from other submarines in that she is completely self-contained. The engines which drive her at speed when submerged are powered by turbines driven by combustion of oxygen from high-test peroxide and diesel fuel. The direct manufacture of oxygen is unique to the submarine, making it entirely independent of the outside atmosphere for its supply.

Air Associates Becomes Electronic Communications, Inc.

A thirty-year-old name in aviation manufacturing receded into the background when Air Associates, Inc., officially changed its name to Electronic Communications, Inc. (ECI).

According to F. W. Godsey, Jr., President of ECI, the new name was chosen because it "more accurately describes the future aims of our company." Henceforth, Air Associates, Inc., will be the name of the widely-known aviation supplies division of ECI.

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Revolutionary TV Screen

The Naval Research Laboratory has developed a revolutionary television screen which permits viewing of television in bright daylight with little loss of contrast, the Navy has announced. The new screen also provides a simplified approach to color TV, and is expected to lead to the development of three-dimensional viewing.

The basis for the new screen is a process for depositing phosphor on the face of the tube in the form of thin transparent film in place of opaque white powders now used. The new films are brighter, sharper, and more rugged than preceding types.

Improved daylight viewing of black and white TV is brought about by contrast obtained with transparent films. Sunlight goes through the film and is lost in the darkened interior of the tube so that contrast is maintained. The elimination of the scattered grains of light on the conventional screens results in the sharper picture.

The transparent film involves a new approach to color television. Films that create different colors can be deposited on top of one another and lighted separately or mixed, by controlling the speed or the direction of the electrons in the tube. By using one film of each of the three primary colors, the complete color spectrum can be obtained through proper mixing. Tubes with all colors are in the experimental stage.

Originally, this work was started for simplifying the operation of jet fighter planes in order to reduce the training time of pilots and help them get the maximum performance from their planes. In part, it involves eventual replacement of the present windshield with a thin transparent display medium. The pilot would get visual and electronic information at the same time and in the same spot. An interim program will utilize a flat transparent television tube installed just inside the wind screen.

Weather Gun Measures Wind

A weather gun that aims at—and hits—itself with a round-trip bullet is the latest experimental device for measuring low-altitude wind velocity, it was announced by the Army. Designed by physicists of the U.S. Army Signal Engineering Laboratories at Fort Monmouth, N. J., it is officially called "Shooting Sphere Anemometer."

Low-altitude wind velocity must be known precisely at the site of a missile launcher in order to hit a bull's eye; even relatively low winds have a significant effect. The new gun, nicknamed "Breeze Buster," provides fast, accurate measurements of these important winds.

By firing a small steel ball upward into the wind at an angle calculated to make the ball fall back into, or close to, the gun's own muzzle, it determines wind velocity. The gun is angled according to the wind velocity; the greater the wind speed, the more the gun is angled. When a successful firing is made, the operator checks the gun's angle of tilt with a calibration chart to obtain a reading of the wind velocity.

The weather gun has certain definite advantages when compared with small pilot weather balloons. Its small steel spheres are inexpensive; it cannot be spotted and shot down by the enemy; it can be used under poor visibility conditions; it measures wind at the testing point, and gives information faster than its predecessor.

Improved Aerial Pictures

Improving aerial pictures is one goal of the military photography section at the Kodak Research Laboratories, Rochester, N. Y.

A small scale model village is used in work on new materials and techniques for aerial photography. Use of the model permits haze, clouds, and other conditions to be simulated for controlled experiments.

Research in the field of military photography was set up as a special section of the Kodak Research Labs last October. Reflecting the growing complexity of military photography, the research section also studies problems in radar photography and various forms of instrument recording photography essential to national defense.

Distinguished Public Service Award

Mr. Donald C. Power, President of General Telephone Corporation, has received the Distinguished Public Service Award given annually by the American Society of Tool Engineers.

The Award was made by Mr. Hartley W. Barclay, Past Chairman of the Greater New York Chapter and Publisher of *Tide* Magazine. He referred to Mr. Power's activities as the "joining of science, education, public service, finance and communications by a man with deep insight into the opportunities in America."

TELEPHONE AND TELEGRAPH EQUIPMENT

Radio Engineering Products is currently producing a number of types of equipment, electrically and mechanically interchangeable with standard Bell System apparatus.

CARRIER-TELEPHONE EQUIPMENT

C5 Carrier-Telephone Terminal (J68756). A kit for adding a fourth toll-grade channel to existing C systems is available. • C1 Carrier-Telephone Repeater (J68757) • 121A C Carrier Line Filter • H Carrier Line Filter (X66217C).

CARRIER-TELEGRAPH EQUIPMENT

40C1 Carrier-Telegraph Channel Terminal (J70047C) • 140A1 Carrier Supply (J70036A1, etc.) • 40AC1 Carrier-Telegraph Terminal.

VOICE-FREQUENCY EQUIPMENT

V1 Telephone Repeater (J68368F) • Power Supply (J68638A1) • V1 Amplifiers (J68635E2 and J68635A2) • V3 Amplifier (J68649A) • V-F Ringers (J68602, etc.) • Four Wire Terminating Set (J68625G1) • 1C Volume Limiter (J68736C).

D-C TELEGRAPH EQUIPMENT

16B1 Telegraph Repeater (J70037B) • 10E1 Telegraph Repeater (J70021A) • 128B2 Teletypewriter Subscriber Set (J70027A).

TEST EQUIPMENT

2A Toll Test Unit (X63699A) • 12B, 13A, 30A (J64030A) and 32A (J64032A) Transmission Measuring Sets • 111A2 Relay Test Panel (J66118E) • 118C2 Telegraph Transmission Measuring Set (J70069K) • 163A2 Test Unit (J70045B) • 163C1 Test Unit (J70045D).

COMPONENTS AND ACCESSORIES

255A and 209FG Polar Relays • Repeating and Retard Coils, several types • 184, 185, 230A and 230B Jack Mountings.

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NEW PRODUCTS FROM INDUSTRY

First 3-Speed Transistorized Record Player

The first 3-speed transistorized portable record player is now offered by the Audio-Master Corp., 17 E. 45th St., New York City.

This unique high fidelity equipment, called the BUTON, is contained in an attractive carrying case measuring 13" x 11" x 5". It is built to rugged luggage specifications and may be conveniently transported. It is specially constructed to withstand jolts and jars, and it is said to perform with concert hall clarity and brilliance.

The BUTON uses four special transistors with an output of 450 mA. The electromotor operates on a 6-volt battery, playing 33, 45 and 78 RPM records. Its frequency range is from 50 to 13,000 cps.

New Lightweight Loop Antenna

A new directional ferrite-core loop antenna, weighing only 7.5 lbs. and using 35% of previous space requirements, has been developed for use in aircraft by the Magnavox Co., Fort Wayne 4, Indiana.

Having a frequency range from 190 to 1760 kc, the new antenna is interchangeable with the loop commonly used with automatic direction finders. It is rotated by a 2-phase motor through reduction gears, which decreases the angular velocity of rotation. A synchro transmitter connected to the rotating antenna transmits the angular position of the antenna to a bearing indicator. A quadrantal compensator corrects errors in bearing indication caused by the aircraft's fuselage in the electromagnetic field.

Flush mounting is readily permitted, and, since the housing extends only 2½" from the aircraft, minimum friction and virtually no airflow damage are possible. Hermetic sealing of components and supporting structures eliminates the need of a dehydrator for moisture control.

Germanium Rectifiers Key To Superior Broadcast Transmitter

A most significant advance in broadcast equipment, a new 50,000-watt AM radio broadcast transmitter has been announced by G.E.'s Technical Products Dept., Syracuse, N. Y.

Maintaining that the key to the transmitter's superior reliability lies in the use of germanium rectifiers, G.E. uses them for the first time to supply high voltage and reduce tube requirements. Dimensions of the new transmitter are 13½' long x 4½' deep. With the use of germanium rectifiers, tube requirements are reduced to 16, weight of the final amplifier tube is lessened to 20 lbs., and only 6 types of tubes are required.

Germanium rectifiers have longer life expectancy than tubes of the present-day transmitters and can be operated at much lower temperatures, allowing the transmitter to be housed in an unheated building.

The new transmitter has built-in provisions for remote operation, although a ruling by the FCC has not yet provided for the allowance.

In addition to the expected lower operating costs, the transmitter's simplicity of design will require much less trained technical skill for maintenance and operation.

New Unit Records Continuously for 24 Hours, Unattended

The SoundScriber Corp. of New Haven, Conn., has announced the successful testing of their compact, magnetic tape recorder/reproducer, the "24," said to be capable of recording continuously, unattended, without tape change, for 24 full hours with the reliable and accurate operation of an electric clock.

Selected by SoundScriber for use in their unit, the DuPont Mylar tape reel measures 3¾" in diameter and 2" wide, holds 300 ft. of tape and operates at the slow speed of 2½" per minute. The tape is calibrated in minutes from 0000 to 1455 for precise place-finding to the second, and is precision-printed in temperature and humidity-controlled surroundings for recording accuracy.

An accessory magnetic tape demagnetizer will bulk-erase a tape reel in 15 seconds, and reels may be quickly changed so as to allow for virtually uninterrupted recordings. Alteration of the recording is said to be impossible without detection.

Designed for use either in a stationary mounting or as a portable unit, the "24" measures 6½" high, 18⅛" wide and 11⅞" deep, weighing only 26½ lbs.

Communications may be monitored through an external headset. Inputs are telephone, line and microphone; outputs are speaker and headset. Operating voltage is 115 volts, 60 cycles, AC.

New Norelco Microradiography Instrument

A new low-cost Norelco contact microradiography instrument for industrial, agricultural and biochemical research has been announced by Philips Electronics, Inc., 750 S. Fulton Ave., Mount Vernon, N. Y.

An image is formed by bringing the specimen into close contact with the emulsion of the photographic plate. After exposure to X-rays for a certain time interval, the plate is developed normally. All details of the specimen are natural size on the negative, but the dimensions can be magnified with a light microscope and photographed. Resolving power is excellent, allowing a magnification of 500.

Geometrical blurring is negligible, and very-fine-grain photographic plates are available for a resolution of better than 0.5 mu.

The instrument employs an X-ray tube which produces very soft radiation, a thin beryllium window (50 mu) and voltages limited to 5 Kv and lower.

When the standard film holder is used, the distance from focus to object is about 15 mm, but can be extended by inserting a spacer tube 9 mm long. Provision is made for cooling the X-ray tube during long exposures.

New British Quartz Crystal Goniometer Now Available In U.S.

A new, high precision quartz crystal X-ray goniometer, which permits unskilled operators to orientate crystal surface and lattice planes quickly to accuracy within 30 seconds of arc, has been produced by Hilger & Watts Ltd., and is being distributed here by the Jarrell-Ash Co., 26 Farwell St., Newtonville 60, Mass.

The Hilger goniometer, Model Y-130, is said to provide a fast, simple means of accurately checking plane alignment of cut quartz and other crystals.

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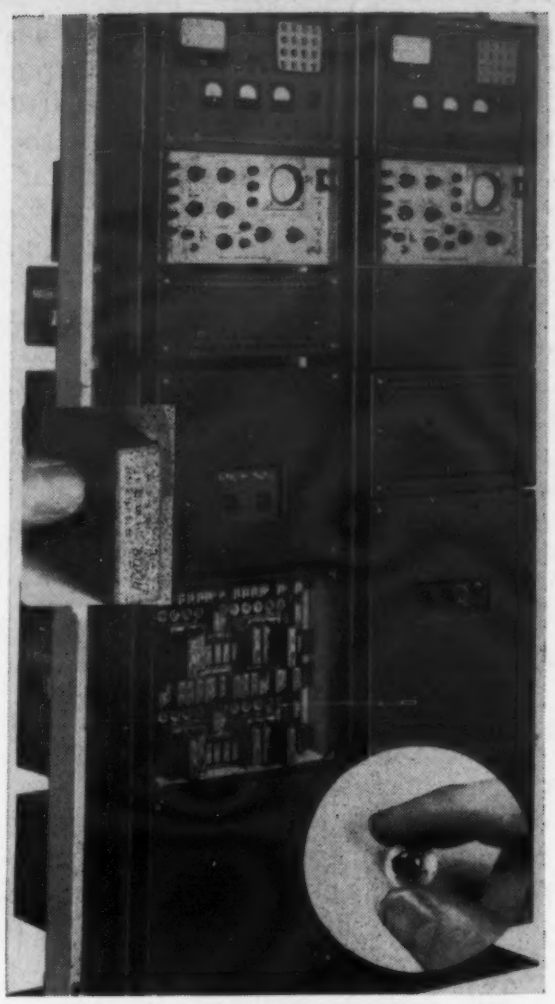

Rixon 16-Channel Teletypewriter Multiplex

16 Channel Teletypewriter Multiplex

The transistorized 16 channel multiplex terminal equipment for teletypewriter communications, designated AN/TCC-35, has been developed by Rixon Electronics, Inc., 2414 Reedie Drive, Silver Spring, Md.

Using time division techniques, the system places up to 16 coded messages onto a single circuit that has a bandwidth as low as 500 cycles per second. The teletypewriter offers speeds of 60, 75 or 100 w.p.m.

Along with transistors, the equipment features miniature magnetic "memory cores" whose high residual magnetism allows them the same storage function as obtained with an Eccles-Jordan (flip-flop) circuit. Occupying very little space, the cores are encapsuled in protective epoxy resin and approximately 1300 are used in the set.

Simplification of servicing results from "potting" standard circuits in expendable plug-in units; 80% of the data-handling circuitry has been standardized into 8 such circuits. Mounted in articulated hinge modules, the chassis is easily accessible from either side of the unit.

A built-in test oscilloscope monitors operation and detects any deteriorating components before failure, thus enabling the system to approach 100% long-time reliability.

Synchronism is automatic within 15 seconds, and is maintained for over 24 hours if the communications should fail. Any binary data in teletypewriter form can be handled.

World's First Linear Accelerator for Industrial Radiography

A 5 million electron-volt linear accelerator (5 Me V), recently produced by Mullard Research Labs., Mullard House, Torrington Place, London, England, is said to be the first of its kind designed specifically for Industrial Radiography.

Supplying more X-ray output and greater energy than any machine previously used for radiography, the linear accelerators also compare favorably with multi-curie radioisotope sources, such as Cobalt 60.

The 5 MeV machine has been designed to render extremely good definition. Despite high energy and the large output of over 500 roentgens per minute at 1 metre, the electron beam which creates the X-rays has a diameter of only 2mm when it strikes the target. In addition, the polar diagram of the output tends to be flatter than is normally associated with such a high energy beam due to a special new magnetic focusing device in the X-ray head.

Only 9 ft. in length, the accelerator has a high degree of mobility which permits movement into the best position for obtaining a radiograph, thus eliminating any need for moving the bulky specimen. Other features include the rotation of its X-ray head, and the ability of the entire machine to be tilted from vertical to horizontal, to be turned laterally through 180°, to be raised or lowered 8 ft., and to be mounted on an overhead rail so that transverse and longitudinal movements are obtainable over the room which houses it.

Use of Color TV Increases X-Ray Readability

The new Exicon research tool, recently developed by Philco Corp. of Phila., Penn., and Einstein Medical Ctr., is said to enable technicians to see trouble spots in X-ray photographs which were often obscured under conventional methods of negative viewing.

Converting shades of contrast into color, the system shows a multi-hued photograph on a TV screen in which different colors represent shades of gray on the negative. Thus, diseased tissues, ordinarily showing up in an X-ray as an almost indiscernible shadow, are more easily identified with the use of full color.

"Exicon," meaning expanded image contraster, uses mainly TV equipment, and consists of monochrome and color monitors, an operators' console and a flying spot scanner.

Widespread industrial application is expected of the system for future uses such as exposing flaws in metal castings, forgings or welds. Other uses under study include aerial reconnaissance, air traffic control and various industrial techniques in chemistry, pharmacology and metallurgy.

Pocket-Size Mobile Radio Receiver

An RCA-developed pocket-size FM radio receiver for commercial mobile communication service was shown for the first time recently.

The fully transistorized, 10-ounce instrument is designed to provide extensions of several miles for radio systems now operating on the 150-megacycle band. In addition, it is constructed for operation on any frequency in the 148-to-174 megacycle band, assigned by FCC for communications applications by numerous Federal, municipal, industrial, and utility services, including the petroleum industry.

Later this year, following nation-

(*Continued on page* 48)

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Radar Tamed for Private Protection

"Radar-Eye," a motion detection instrument developed by Radar-Eye Corp., North St., Natick, Mass., now provides industry and business with a new method of protection against burglary or intrusion.

Within an operating radius of 25 ft. in any direction from its antenna, the Radar-Eye is extremely sensitive to any movement. Invisible radar waves instantly turn on floodlights and set off a screaming alarm which will operate as long as any motion continues including one minute thereafter. Tamperproof wiring sounds the alarm when any attempt is made to open the unit or cut off its power. In addition, the Radar-Eye shuts off and resets itself automatically.

This portable unit can be installed behind non-metallic walls, and a remote control key switch permits control from outside the premises. For added protection, an accessory fire detection circuit and alarm may be obtained.

Using less current than a 60-watt bulb, the unit operates on 115V. AC, 60 c.p.s. single phase. Its compact dimensions including antenna are: 17¼" long, 10⅞" deep and 25¾" high.

High Temperature, Low Capacitance Teflon-Air Dielectric Cable

An entirely new teflon-air-dielectric miniature coaxial cable has been developed by The Tensolite Insulated Wire Co., Inc., 198 Main St., Tarrytown, N. Y.

Having a nominal overall diameter of .220", the cable is available with a choice of outer jackets of teflon, such as lacquered nylon braid and silicone impregnated glass braid. The conductor is #30 AWG, 7/38 silver-plated copperweld.

Its low attenuation makes the 10 MMF cable particularly serviceable for high frequency, low level applications and as a low capacitance probe cable. Capacitance values of less than 10 MMF, having somewhat larger diameters, are available on request.

Featuring excellent flexibility, the new coaxial cable has the added advantages of solderability, light weight, small size, and ready adaptation to a variety of connectors.

New Hermetically Sealed Inductive Components

Now offered by Electro-Tech Pacific (ETP), Box 455, Goleta, Calif., is a new line of hermetically sealed inductive components which feature high inductance, small physical size, low harmonic distortion and great stability under wide temperature ranges.

Provided with the best shielding available, these inductive components are insulated to withstand potentials of high orders of magnitude, and designed specifically for very low frequency performance. Humbucking construction is used on all ETP inductors and transformers, along with varnish vacuum impregnation. All units are tropicalized and hermetically sealed.

In all, it is claimed that these features insure circuit elements having exceedingly long life and exceptional stability.

New 24-Hour Multiple Operation Time Switch

Completely automatic control of intermittently operated equipment is provided by the versatile 24-hour time switch recently developed by Zenith Electric Co., 152 W. Walton St., Chicago, Ill.

Handling as many as 48 "on" and 48 "off" operations a day, the switch can be used in control of oil wells, heating and air conditioning equipment, stokers, oil and gas burners, etc.

Running periods are set by sliding self-contained, nonremovable trip levers in or out on a control dial, scaled in 15-minute graduations. A daily operating schedule can be set up to repeat automatically each day, or a calendar cutout device, available as an accessory, can make the switch selective for each weekday, including provision for non-working days.

Powered by a heavy duty, synchronous industrial motor lubricated with low-temperature oil, the mechanism capacity is rated at 1000 watts, 60 cycle AC, and the action is single pole, double throw.

New Literature

"Battleground U.S.A."

Entitled "Battleground U.S.A.," a 117-page publication has been issued by FCDA, proposing a plan for the operational readiness of civil defense agencies in the event of enemy attack. Supplemented with 21 maps, the guide details every phase of civil defense actions necessary within a hypothetical target area, and emphasizes the need for adjusting the plan to the peculiar laws, administrative arrangements, readiness, and geographical characteristics of each political jurisdiction.

The FCDA plan covers operations of the metropolitan target area's defense forces during a tactical alert, the attack itself, and the immediate post-attack period. To clear way for civil defense operations, the State's emergency legal powers are also identified.

Tape Wound Core Catalog-Design Manual

"Performance-Guaranteed Tape Wound Cores," a 28-page catalog-design manual compiled by Magnetics, Inc., of Butler, Penn., features a comprehensive section for engineers and scientists interested in applications of high permeability magnetic materials.

The manual supplies information on magnetic terminology, design equations and material characteristics of tape wound cores together with detailed methods of testing and core matching. Also included are tables devoted to basic units and conversion factors and the properties of nickel-iron alloys with their magnetic values. Finally, a bibliography is offered.

Listing all standard and many non-standard sizes, the catalog describes the advantages and construction of the tape wound cores and contains a section given to the ordering and matching of cores.

Teflon Superior to Mica For Capacitors

Obtainable from OTS, U. S. Dept. of Commerce, Washington 25, D. C. is a 79-page report describing the use of Teflon in electronics where capacitors of the polytetrafluoroethylene material were found superior to those of mica.

A revolutionary dry lubricant and preservative for metals, Teflon met or exceeded all requirements for replacement of mica capacitors under temperatures from —60 to 200 C., excepting the r-f current rating which was unapplicable to metal-cased units due to overheating.

Development of Subminiature High Temperature Capacitors, PB 111729, reveals two remaining obstacles before Teflon capacitors could replace mica units in any application: stabilization of capacitor elements and encasement for radio-frequency operation.

UMI

ELECTRONICS IN INDUSTRY, 2nd Edition, by George M. Chute. McGraw-Hill Book Co., New York, N. Y. 431 pages, $7.50.

This textbook is designed for engineering students and for men in the electronics industry who use and service industrial electronic circuits and equipment.

Uses of vapor or gas tubes are stressed. The tube circuits presented in this volume are commonly used in practical industrial equipment, and the text deals exclusively with equipment designed and built for industrial applications.

The revised edition has been brought up to date with an additional chapter on simple closed-loop systems for a background of feedback controls. Recent designs of industry have revised these controls.

THE ART AND SCIENCE OF PROTECTIVE RELAYING, by C. Russell Mason. John Wiley & Sons, Inc., New York, N.Y. 410 pages, $12.00.

This volume is an outgrowth of notes used in the Power Systems Engineering Course given by the General Electric Company. It assumes no prior knowledge of protective relaying. The student needs to know only the fundamental principles of electrical engineering. The included material, which has been tested in the classroom, is not only an introductory guide for the novice but also serves the practicing relay engineer with a storehouse of refresher information on principles of relay design and application.

The text deals with fundamental relay-operating principles and characteristics, including a description of the various types of relays. The relation of relaying to other power-system elements is discussed. Instructions on interpreting relay response are included.

The concluding chapters discuss line protection with relays of the overcurrent, distance, and pilot types.

Complete references to basic source material are given.

NIGHTMARE OF THE INNOCENTS, by Otto Larsen. Philosophical Library, Inc., New York 16, N. Y. 240 pages, $6.00.

A Norwegian fisherman, for no discoverable crime, had been arrested by the Russians and sentenced to 10 years hard labor in the slave camps of the Soviet Union. Now, in this book, Otto Larsen tells the terrifying story of his experience in that world of nightmares.

The author's laconic words bring through the anguish of his stark chronicle with a penetrating fervor. Revealing the intense fear animating the Soviet Regime together with the extraordinary stupidity common to such despotisms, he presents a vivid record of man's inhumanity to man.

Having found the narrative impressive in its unadorned truthfulness and wealth of illuminating detail, Bertrand Russell calls it "quite extraordinarily moving."

RESONANT CIRCUITS, ed. by Alexander Schure. John F. Rider, New York, N. Y. 72 pages, $1.25.

Volume 16 in the paper-bound Electronic Technology Series is concerned with resistors, capacitors, and inductors which are found in various series, parallel, or series parallel resonant combinations in electronic circuits.

The essential theory related to resonance is reviewed and followed by discussions on the theory of series resonant circuits, delineating the computations relating to resonant frequency, the voltage relationships, and the role of the figure of merit (Q) in these circuits.

Similar analyses for the elements comprising parallel resonant circuits and the circuits themselves are included.

The rest of the theoretical material treats resonant coupled circuits, including the coupling coefficient, reflected impedance, and the effects of coupling upon resonance.

A few basic applications are described. These are typical of the general uses of the circuits and give an understanding of general circuit arrangements.

LINEAR TRANSIENT ANALYSIS, Vol. II, by Ernst Weber. John Wiley & Sons, Inc., New York, N. Y. 452 pages.

This volume presents a college graduate course in two-terminal-pair networks. As a sequel to Volume I of *Linear Transient Analysis*, it presupposes knowledge of the functions of a complex variable and familiarity with simple lumped circuits. However, the appendices provide mathematical background which helps make the work self-sufficient.

Also included is a brief review of the Fourier and Laplace transforms. Their uses in analyzing fourpoles and transmission lines are emphasized. An unusually comprehensive treatment of the two-terminal-pair network is presented in simple matrix algebra.

Although the book is essentially a mathematical discussion, it offers numerous practical applications.

RADIO AIDS TO AIR NAVIGATION, by J. H. H. Grover. Philosophical Library, Inc., N. Y. 138 pages, $6.00.

Stressing performance, capabilities and methods of operation of the different types of navigational radio equipment, this author has fully covered the most important civil systems in current use in Europe and America, with a minimum of technical description.

After an introductory chapter on general principles, M.F. and V.H.F. systems are described. Two chapters are devoted to important hyperbolic aids, followed by a discussion of pulse systems, aids to traffic control, aids to approach and landing. In addition, future aids and trends, charts, documents and regulations are included. Finally, two appendices, table of radio aids, and formulae and conversion factors are offered.

This volume provides the student preparing for his civil license examination with all the basic knowledge required regarding radio aids to air navigation. For the qualified navigator and pilot, it will serve as an excellent reference guide.

AN INTRODUCTION TO JUNCTION TRANSISTOR THEORY, by R. D. Middlebrook. John Wiley & Sons, Inc., New York, N. Y. 296 pages, $8.50.

This study provides a background for the electronic engineer who is interested in transistors and how they operate. It serves as a connecting link between the physical processes in semi-conductors and the circuit properties of a junction transistor.

The text is divided into three parts. The starting point is a discussion of crystal structure and the motion of electrons in crystals. Upon this foundation, a continuous development of the basic theory of transistor action is presented.

The major purpose of the study is to develop basic junction transistor theory. It introduces a new equivalent circuit, based on this theory, which can be used in practical applications.

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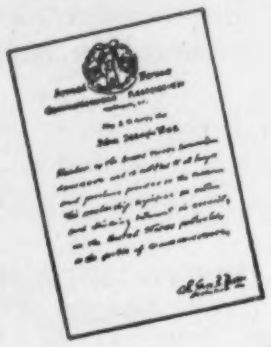

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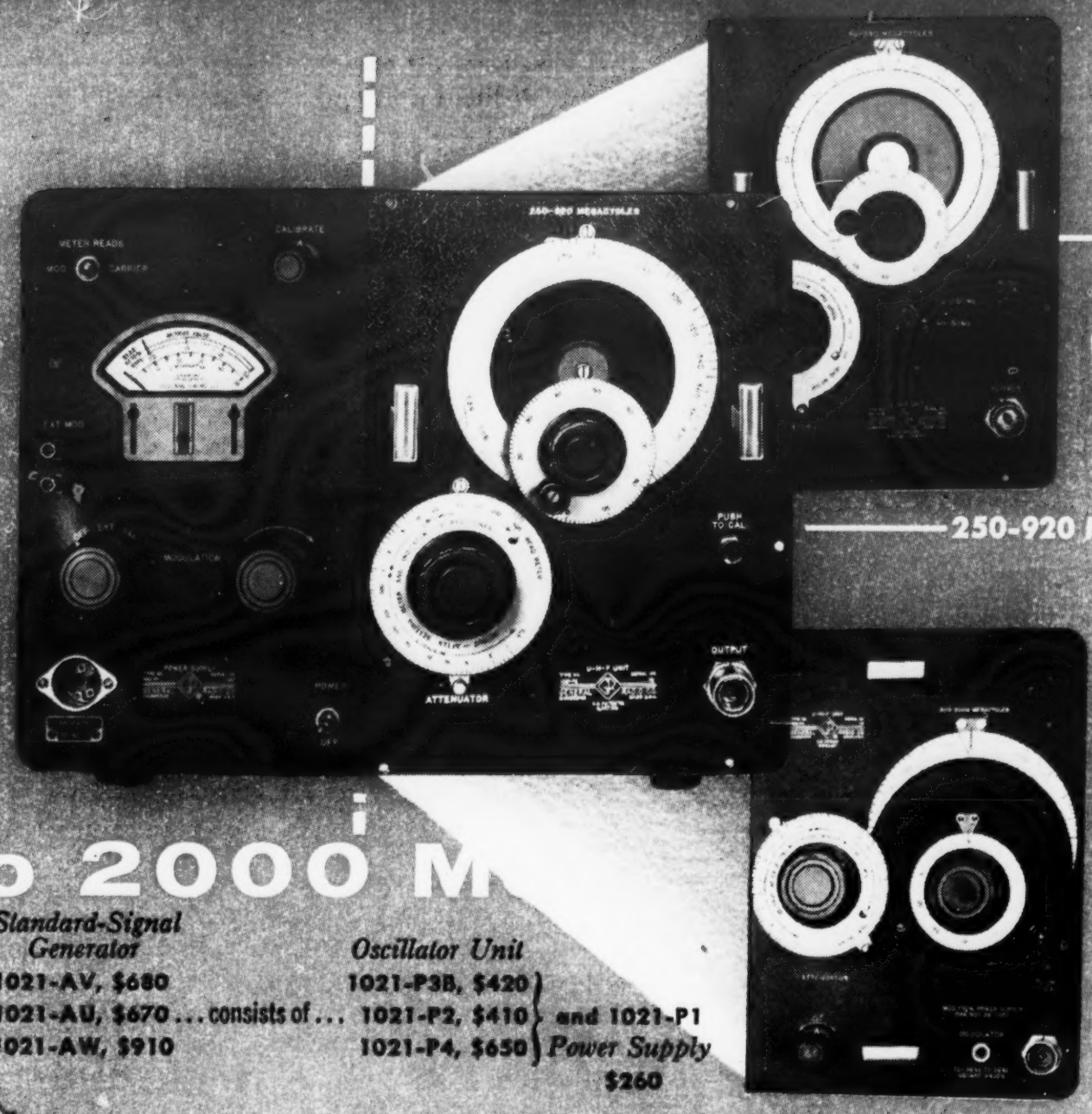

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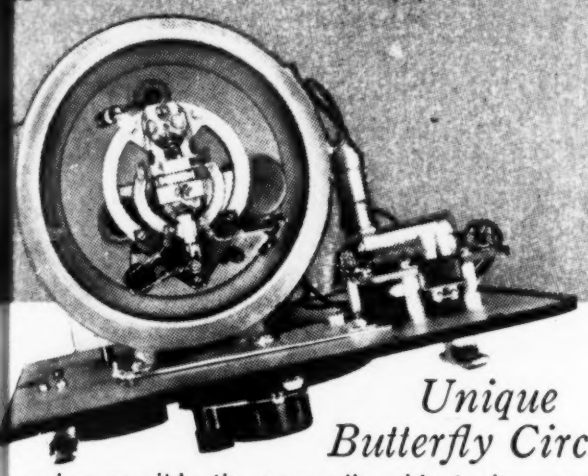

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